CHAPTER 7: ENVIRONMENTAL RESILIENCY

"Resiliency" is essentially a measure of the ability to "bounce back" or recover from negative impacts. A resilient environment then, is one that has the strength and health necessary to continue functioning ecologically – to go on freely providing the "ecosystem services" that support life on earth. These invaluable services are naturally occurring processes that would be extremely costly and impossible to engineer – including the removal of harmful pollutants from the air and water, climate stabilization, mitigation of natural hazards such as flooding, and the provision of food and habitat for the other species of life that have important ecological roles to play. In fact, "biodiversity," or the variety of species an environment can support, is perhaps the most significant measure of that environment's resiliency. Therefore, what is good for other species of life is also good for us.

Green Infrastructure

The complex, living network of natural systems and processes that perform these vital functions can be thought of as "green infrastructure" (in contrast with the grey, concrete materials of built infrastructure). More commonly known for its beneficial role in stormwater management, green infrastructure at a broader scale can be conceived of as all the natural elements of the landscape that work together to perform the work of ecosystem services and support the life of its inhabitants. Because of the broadly mitigative effects and multiple benefits of supporting green infrastructure health wherever possible, the Long Range Transportation Systems (LRTS) guide provides additional information on implementation of "Green Street" design - roadways that incorporate green stormwater infrastructure (GSI) and low-impact development (LID) principles.

Federal Requirements

Federal law requires that long-range transportation plans include identification of "natural resources" that may be impacted by transportation development, identify potential areas for implementing mitigation activities, and discuss what types of mitigation activities have the greatest potential to restore and maintain their environmental functions. Environmental impact areas most often associated with transportation development are:

1. Habitat fragmentation
2. Wildlife movement conflicts
3. Altered hydrology and water contaminants
4. Air pollution and greenhouse gas emissions

While new construction projects may require more site-specific study of associated environmental impacts, the following subsections of this chapter provide further information on each of these along with some general mitigation measures.

Climate Change Impacts

For the previous MTP, the Mid-Region Council of Governments was awarded a federal grant to incorporate climate change considerations into its transportation planning process. As the transportation sector of the economy is the leading source of climate-disrupting greenhouse gas emissions in the United States, this was a relevant and timely topic to address. The study examined the relationship between growth patterns, development pressures, and climate change projections unique to our inland, southwestern region.

As a part of this *Central New Mexico Climate Change Scenario Planning Project (2015)*, MRMPO consulted with federal, state and local wildlife, land management, and regulatory agencies to identify environmental impacts associated with climate change projections.[1] This project established that increasing temperatures and variability of precipitation levels will place increasing strain on plant and wildlife species in our region, as well as increase risks of drought, wildfires, and flooding. To support regional stakeholders in reducing exposure to these hazards, this chapter also includes discussion of mitigation measures and examines the relationship between areas of heightened risk and the development patterns of the Trend and Target Scenarios.

7.1 Crucial Habitat

a. Environmental Landscape

Located in the Middle Rio Grande Watershed, the AMPA contains mountain peaks and riverbeds, is made up of eight distinct "eco-regions", and therefore home to a surprising diversity of native plant and animal life. Not always green, it is nonetheless fairly rich in "green space" - home to the Cibola National Forest, Sandia and Manzano National Wilderness Areas, Rio Grande Valley State Park (the Bosque), and hundreds of parks and open spaces. The map below highlights these conserved public parks and open spaces in relation to natural and manmade water channels, together the natural recreation areas available to most residents of the region. Our networks of trails, transit service, sidewalks and roads connect people to these amenities, and its important that the access provided be as equitable as possible. Further discussion and analysis of accessibility to natural recreation amenities can be found in the Environmental Justice chapter of the MTP.

b. Habitat Fragmentation

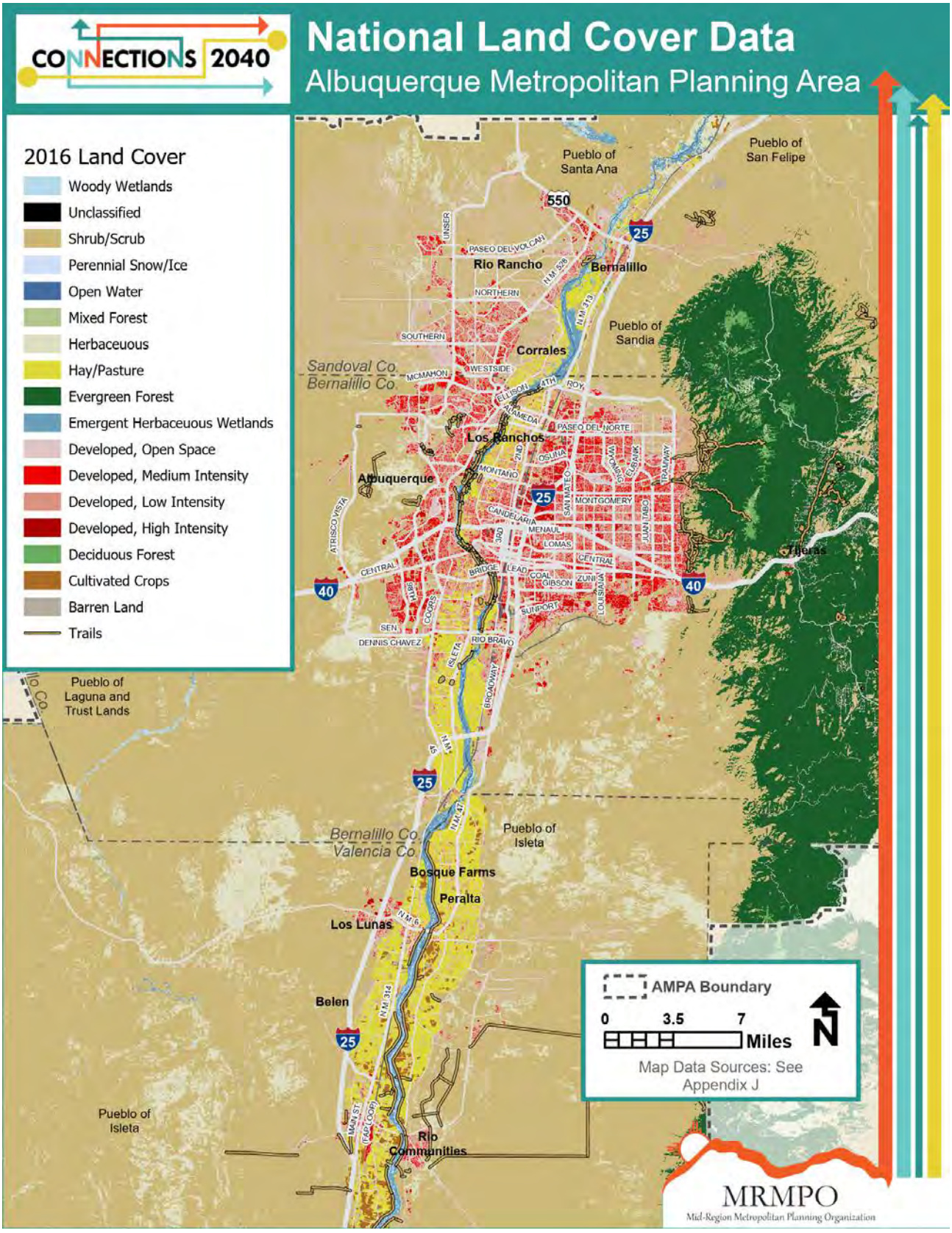
For a species to survive in a landscape or watershed, it must have access to habitat resources sufficient to maintain a viable population. Transportation networks criss-cross the landscape, which fragments and degrades habitats by introducing light, noise, pollutants, and competitor species along the edges of bisected habitat areas. All of these "edge effects" cause wildlife to modify their behavior and change micro-climatic conditions that limit the species that can continue making use of the land as habitat.

For vegetation, transportation and utility corridors act as reservoirs and conduits for invasive and problematic species, particularly plants in arid environments. Vehicles are a continuous source of non-native seeds, and rights-of-ways are particularly fertile grounds for weedy species that germinate and seed quickly. These areas also receive supplemental water from pavement runoff and are subject to frequent disturbance from road and vegetation maintenance - characteristics which inhibit establishment of slower-developing native species.[2]

[1] The following federal agencies provided funding and/or technical assistance for the Central New Mexico Climate Change Scenario Planning Project: the Federal Highway Administration, U.S. Department of Transportation Volpe Center, U.S. Fish and Wildlife Service, Bureau of Land Management, U.S. Army Corps of Engineers, Bureau of Reclamation, National Park Service, U.S. Forest Service, Federal Transit Administration, Federal Emergency Management Agency, Department of Homeland Security, , and the Environmental Protection Agency. For more information, please see the "Climate Change Project" link on the MRCOG website.

[2] New Mexico Department of Game and Fish. 2016. State Wildlife Action Plan for New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA

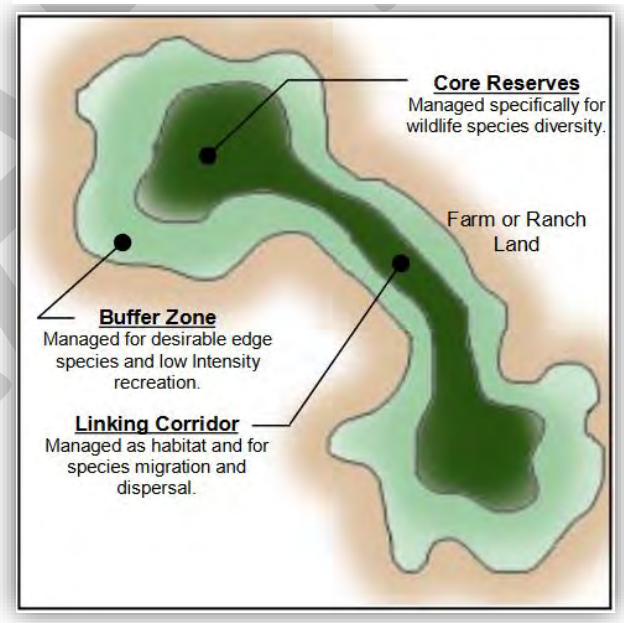
Map 7-1: Land Classifications with Trails



Habitat edges also act as barriers to movement, causing some predators to travel along them. High predator densities along edges can result in higher mortality for edge-dwelling prey species or species moving through narrow corridors. As remnants of native habitats become smaller, they are also less likely to provide the food, cover, and available mates necessary to support the native wildlife community. Landscape ecologists and conservation biologists have formulated several basic concepts and principles that can be used to guide wildlife planning at the watershed scale. They focus on the spatial relationships between patches, corridors, and the matrix. Developed for regional landscapes and large protected patches (national parks, wildlife refuges, etc.), they are equally effective at smaller scales. Understanding these concepts and principles can help land managers make informed decisions about how best to use corridors to recreate landscapes that are more functional.[3]

An ideal pattern for wildlife conservation would preserve important nodes (core reserves), provide corridors (linkages) between nodes, and establish multiple use (buffer zones) around the nodes and corridor. This pattern satisfies wildlife needs and buffers potential adverse impacts originating in the matrix. It also provides opportunities for low-intensity human use of the buffer zones around the reserves. In addition to these three concepts, a number of ecological principles can be used by land managers to configure patterns of landscape elements most beneficial to wildlife:

Figure 7-1: Core Reserves, Buffer Zones, and Linkages (after Adams and Dove, 1989)



Patches

- Large reserves/patches of vegetation are better than small reserves/patches.
- Connected reserves/patches are better than separated reserves/patches.
- Several reserves/patches (redundancy) are better than one reserve/patch.
- Nearness is better than separation.

Corridors

- Continuous corridors of vegetation are better than fragmented corridors.
- Wider corridors are better than narrow corridors.
- Two or more corridor connections between patches (redundancy) are better than one.
- Natural connectivity should be maintained or restored.

Structure

- Structurally diverse corridors and patches (convoluted horizontal boundaries and vegetation of various heights) are better than simple structures.
- Native plants are better than introduced plants. [4]

[3] USDA, NRCS. November 2004. National Biology Handbook. Title 190, Subpart B – Conservation Planning, Part 613: Conservation Corridor Planning at the Landscape Level – Managing for Wildlife Habitat. Washington, DC.

[4] USDA, NRCS. November 2004. National Biology Handbook. Title 190, Subpart B – Conservation Planning, Part 613: Chapter 5: Planning & Design Principles. Washington, DC. Pp.5-1,5-2

c. Wildlife Movement

Many species use the cover of tree canopies and connected areas of vegetation as travel corridors for linking various habitat resources within their home range. Roads crossing these important routes increase risk of dangerous wildlife-vehicle collisions and act as barriers to safe movement for animal life-cycle requirements such as seasonal migrations for breeding, birthing, or feeding. This circulation is critical to meeting the survival needs of various species, and safe movement can be facilitated through a number of design options.

Figure 7-2: Tijeras Canyon Safe Passage Project

Tijeras Canyon Safe Passage

A successful regional example of this is the Tijeras Canyon Safe Passage Project. In 2011, Senator Mimi Stewart (D-Albuquerque), sponsored a memorial directing the New Mexico Department of Transportation (DOT) and New Mexico Department of Game and Fish to develop a traffic safety pilot project to reduce wildlife-vehicle collisions and support the migration needs of several important species. The Tijeras Canyon Safe Passage Project was the result of this initiative.

This passage is located at a critically important point for wildlife movement where I-40 and State Highway 333 pass through Tijeras Canyon. The canyon links the Sandia and Manzano mountains, and the creek running through it is the only source of water for wildlife for miles around. The project successfully facilitates safe animal crossings by using eight-foot-tall game fences to funnel animals coming down from the Sandias into a single spot across NM 333. There, their weight activates flashing lights that warn drivers to slow down. If they try to head up or down the highway, an electrified mat on the roadway delivers a slight shock. Once across and down in the creek bed, animals can pass below I-40 and make their way into the Manzanos, or head back to the Sandias.[5]

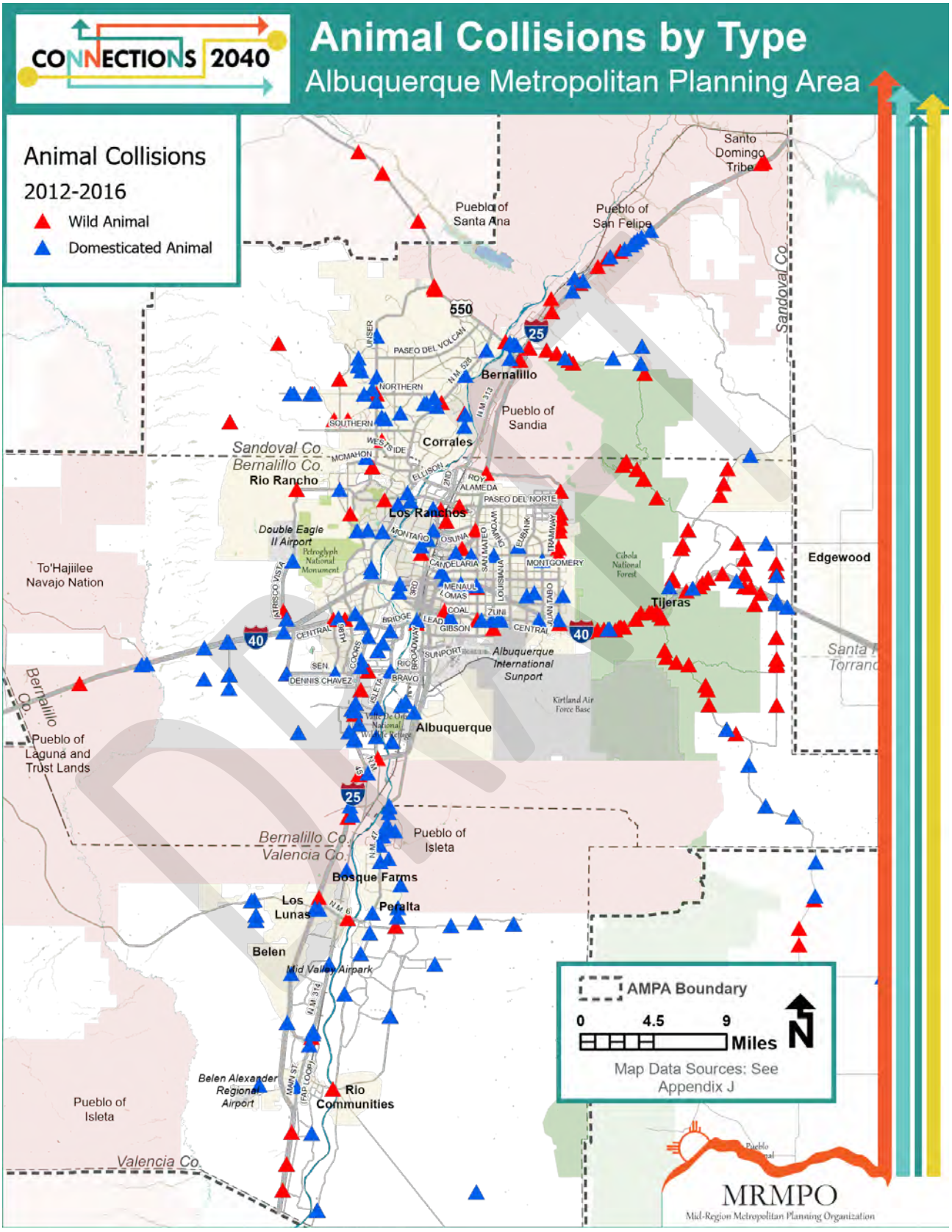
Wildlife Corridors Act

Another regionally significant event is the recent passage of the Wildlife Corridors Act. Signed into law March 2019 by New Mexico Governor Michelle Lujan Grisham, the Act directs the New Mexico Department of Game and Fish and the state Department of Transportation to develop an action plan to identify key roads and other barriers impacting wildlife migration and to direct construction for safe animal passage and road safety. This legislation will be a paramount stepping-stone in ensuring that populations of deer, elk, pronghorns, black bears, and other key species can safely traverse their habitats across the state.

The map below identifies known locations with high incidence of wildlife vehicle collisions with key corridors identified in the New Mexico Forestry Division's Statewide Strategy and Response Plan, identifying where opportunities for new connections may be made between existing natural areas.

[5] http://nmpoliticalreport.com/2018/09/17/safe-passage-getting-wildlife-where-they-need-to-go-en/

Map 7-2: Wildlife – Vehicle Collisions, 2012-2016



d. Crucial Habitat Assessment Tool (CHAT)

The New Mexico Crucial Habitat Assessment Tool (NM CHAT) provides a visual exploration of wildlife data while preserving the confidentiality of sensitive information. It was developed to bring greater certainty and predictability to planning efforts by establishing a common starting point for discussing the intersection of development and wildlife. It is designed to reduce conflicts and surprises while ensuring wildlife values are better incorporated into land use planning, particularly for large-scale linear projects. It provides landscape-level, non-regulatory, conservation information to support project planning, but is not intended for project-level approval and does not replace or supersede site-specific consultation with appropriate agencies, including the New Mexico Department of Game and Fish (NMDGF) and the U.S. Fish and Wildlife Service.[6] For the map, one indicates areas most likely to provide crucial habitat and conservation potential, depicted in darker blue hexagons.

Trend vs Target Scenario

To compare how the MTP scenarios would affect crucial habitat areas, MRMPO's land use model was run to assess potential future development growth in these areas. In this way a composite score was developed to evaluate overall performance of the Trend and the Target Scenarios.

Table 7-1: Trend and Target Scenarios Comparison of Development in Crucial Habitat Areas

[In process of being updated]

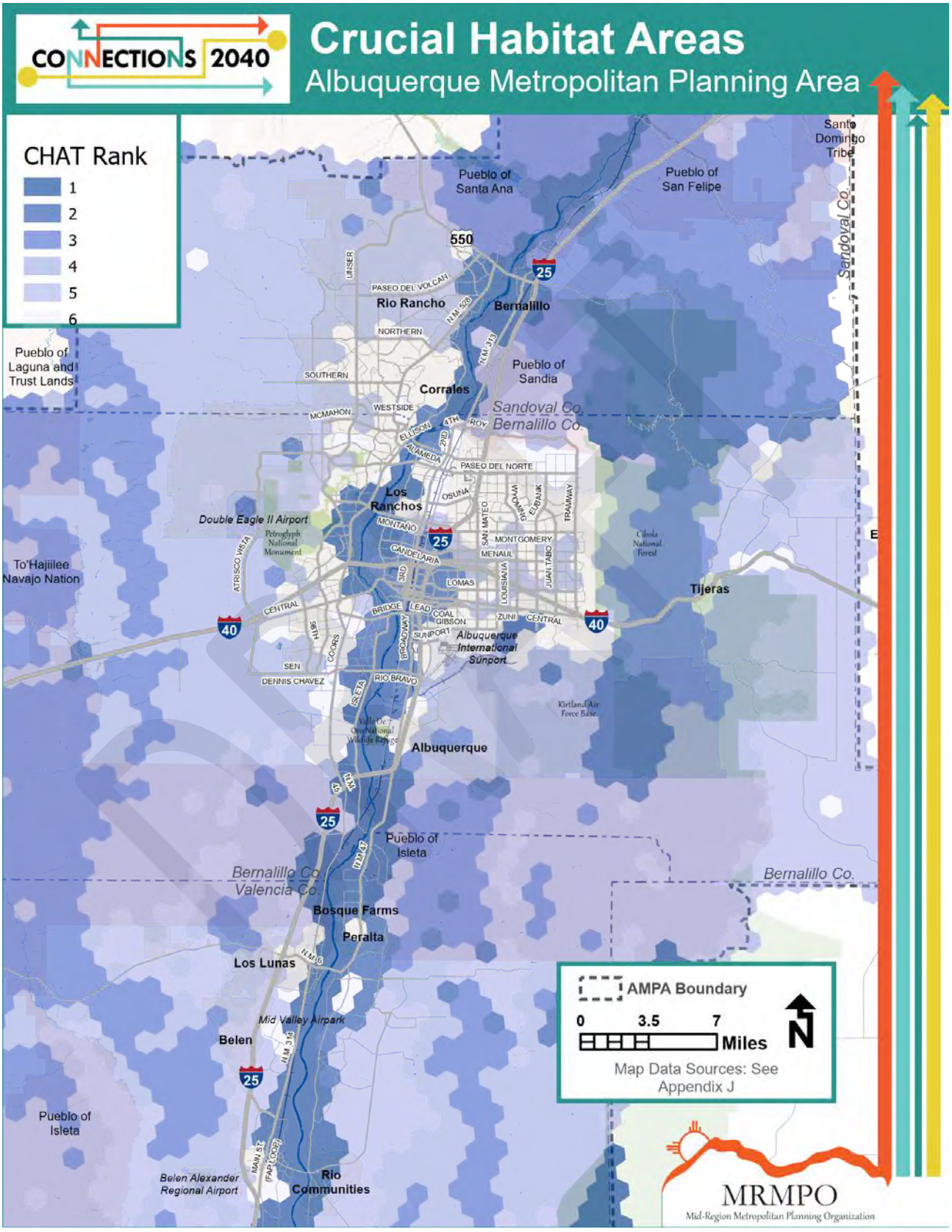
New vs Existing Development

Model rankings do not identify instances where wildlife species are threatened by human impacts, but rather the locations that are most critical to preserve. It is therefore important to distinguish between the impacts of existing versus new development since many impacts are already felt. It is generally preferable to allow additional growth in places that have already been developed since the species that inhabit these areas are more adapted to urban living.

Impacts on less crucial areas with no existing development are greater than the impacts of further development in locations already part of the human-wildlife interface. Nevertheless, since the Target Scenario includes additional housing and employment in locations with existing development near sensitive habitat areas, it is important to reconcile development and habitat needs.

[6] *About New Mexico Crucial Habitat Assessment Tool.* nmchat.org/about.html. Accessed 25 November 2019.

Map 7-3: Crucial Habitat Assessment Tool (CHAT)



e. Bernalillo County Greenprint

An alternative to using CHAT for this region is the Bernalillo County Greenprint, which could be used for emulating a similar process for other counties in the region. The Greenprint is a comprehensive mapping process recently undertaken when Bernalillo County's Open Space Division partnered with the Trust for Public Land (TPL) to produce a county-wide "Greenprint" with broad stakeholder input to guide where public funds should be spent to protect open space. The Greenprint process was initiated when Bernalillo County voters approved Milly Levy funds designated for the purpose of "acquiring, improving, operating, and maintaining natural areas, open spaces, and cultural, historic, and nature education sites within the County to protect drinking water sources, wildlife habitat and agricultural land, including along the Rio Grande, and to allow children and families to get outdoors in nature."

The resulting GIS models, maps and Project Assessment Tool allowed properties to be scored by how well they support a selected range of conservation priorities identified as being important to the public, including protection of wildlife habitat. Other resource conservation goals were to:

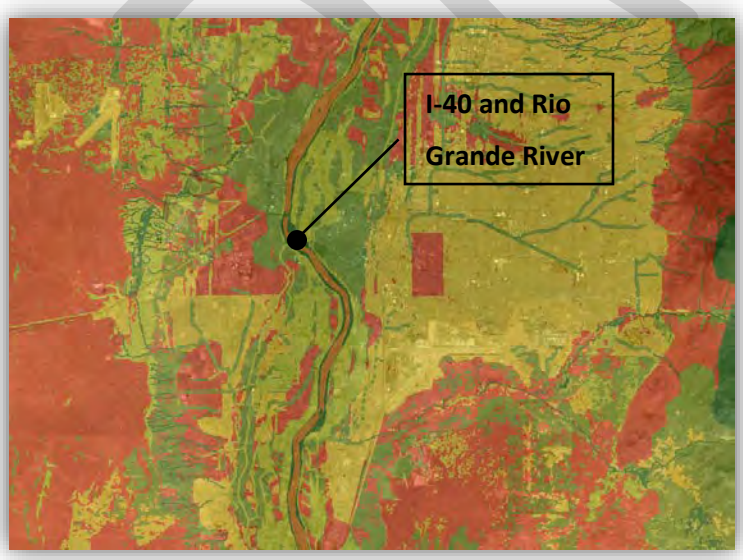
1. Protect water quality in rivers and streams (top community priority);
2. Preserve local agriculture and food production;
3. Protect important cultural and historical sites, and to;
4. Provide public access to healthy outdoor recreation.

To identify the lands most valuable for conservation as wildlife habitat, the model combined data from multiple wildlife management agencies, including the NM Department of Game & Fish, the Fish & Wildlife Service, the US Forest Service, and in consultation with agency biologists developed a weighting scheme to highlight those areas identified by these multiple sources as having conditions attractive to wildlife.

Greenprint High Ranking Locations

In the figure shown, the darkest green areas are those ranked with highest value, and those in red of lowest value. Clearly, the model indicates that overall, high elevation mountain forest and vegetated riparian areas near the rivers and natural acequias best meet the resource needs of a variety of local wildlife.

Figure 7-3: Bernalillo County Greenprint Close Up



Due to the selected model criteria, the highest valued habitat is in some places located directly adjacent to the lowest valued, but the ecology of "edge effects" as discussed earlier indicates that encroachment of intensive development reduces habitat value, and areas immediately adjacent to high quality habitat are also valuable to conserve or improve upon for wildlife needs.

7.2 Water Resources

Discussions surrounding growth and development within a drought-stricken, arid region of the United States inevitably develop into a debate around the availability of water and how prepared or unprepared central New Mexico is to accommodate the forecasted growth within the region. The discussion on growth would be lacking if it did not at least recognize the role that water availability and future demands plays in overall future development.

a. Regional Water Planning

The Middle Rio Grande Region is one of 16 water-planning regions in New Mexico. It comprises Sandoval, Bernalillo, and Valencia counties—an area covering more than 5,000 square miles. Around half of New Mexico's population lives within this area, making the region the largest urban water user in the state. Guided by the New Mexico Office of the State Engineer Interstate Stream Commission, the first regional water plan was created in 2004. The development and implementation of this initial water plan was intended to support policies, programs, and projects that meet the goals of the plan. Recognizing the limited resources and consistent overuse of the region's water, the mission of the regional water plan was to balance water use with renewable supply.

Mid-Region Council of Governments Water Resources Board

In 2014, the State of New Mexico began the process of updating the regional water plans throughout the state, enlisting support by the groups previously involved in their creation. Specific to the Middle Rio Grande Regional Water Plan, the Interstate Stream Commission (ISC) began utilizing the Mid-Region Council of Governments Water Resources Board to develop a steering committee to guide the development of the update for this region. Throughout 2015, the steering committees worked with the ISC and the general public to update the plans for scheduled adoption by the state at the close of 2015. Based on the inherent link between transportation, land development, and the availability of water, it is important for future MTPs to include and reference information within the regional water plans, and for the regional water plans to reference the projections for population growth and areas of development demand contained in the MTP.

Water Supply & Demand in the Southwest

There are many climate change implications relating to water availability within the southwest. First, usable, manageable water supply is projected to decline. Due to the anticipated (and continued) loss of winter snowpack, supply of water as well as the ability to store water in the U.S. southwest, will likely decrease. Second, there will be a projected simultaneous increase in water demand for landscaping, irrigation, and agriculture due to the projected increases in temperature and increased commercial and residential demand due to population growth. The projected decrease in water supply will be intensified by this increase in demand, and the gap between supply and demand will be expected to continue to grow.

The administrative water supply is based on 2010 withdrawals of water and is an estimate of future water supplies that considers both physical availability and compliance with water rights policies. Because of its reliance on surface water, the region has a high degree of vulnerability to drought, especially for irrigated agriculture, and the estimated annual shortage in drought years is expected to range from 207,357 to 282,108 acre-feet. Figure below illustrates the total projected regional water demand under high and low demand scenarios, and also shows the administrative water supply and the drought-adjusted water supply.

Figure 7-4: Total Regional Water Use by Sector, 2010

Note: Tribes and Pueblos in New Mexico are not required to provide water use data to the State.[7]

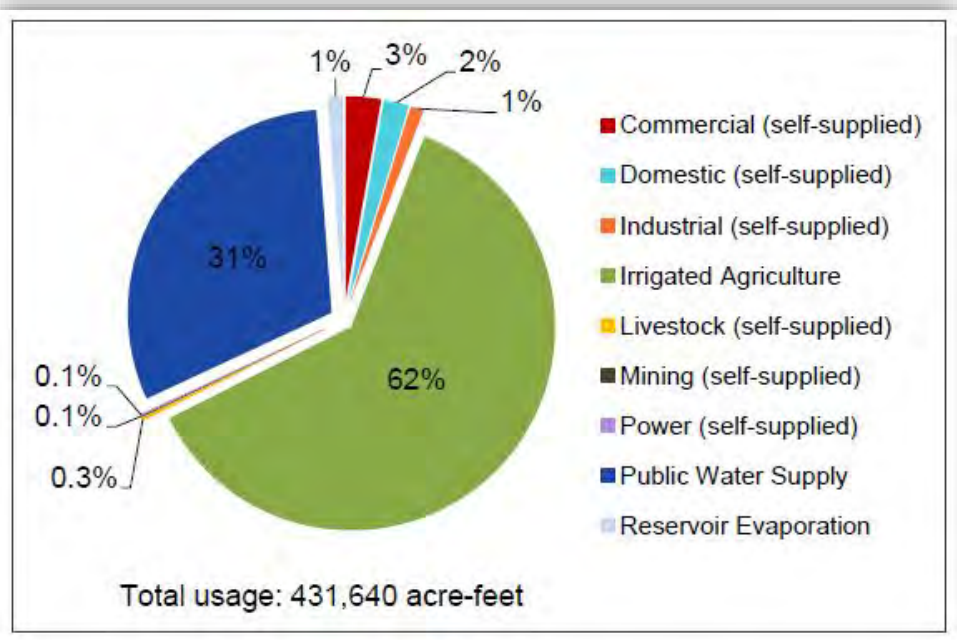
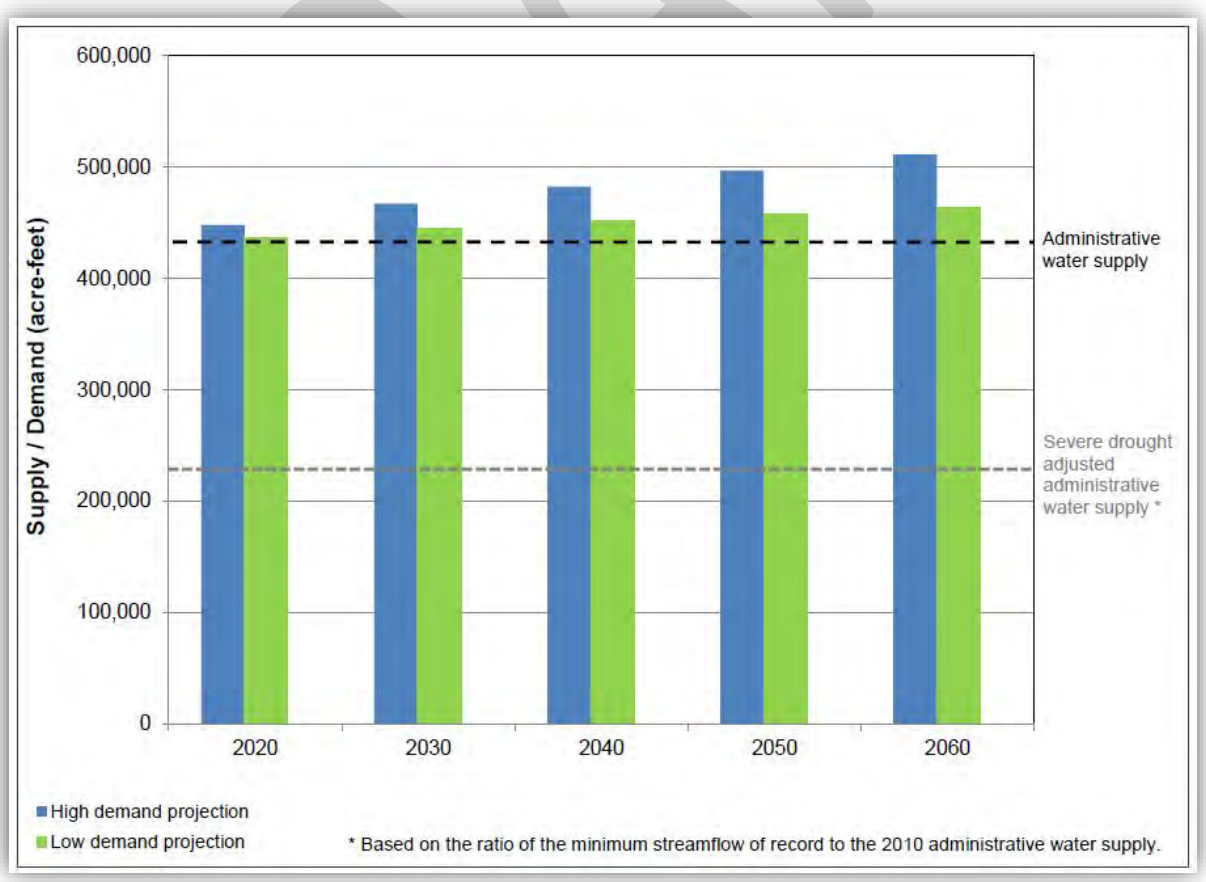


Figure 7-5: Available Supply and Projected Demand[1]



[7] Figure ES-2. Total Regional Water Use, 2010. Executive Summary, Middle Rio Grande Regional Water Plan, 2017

Land Use Impacts in the Region

While water management and climate change adaptation plans will be necessary to lessen the impacts, they cannot be expected to counter the effects of climate change. The climate change project helped establish that, in addition to population growth distribution, land use practices influence how much water is needed for general consumption. How the region grows impacts demand through the types and density of development and the resulting landscaping and irrigation needs.

b. Water, Transportation, and Land Use Connection

This section addresses the link between water, land use, growth and development, and transportation within the region. Rather than engaging in an argument about whether the region *should* grow, such knowledge can help inform how the region *can* grow most sustainably. Given that the region faces less precipitation, or precipitation occurring in major events, as well as increasing temperatures that are likely to increase drought conditions and limit water availability, it is important to consider the relationship between future land use and future water demand. Unlike the *Upper Rio Grande Impact Assessment,* which considered effects on water supply, the *Central New Mexico Climate Change Scenario Planning Project* evaluated the impacts of the built environment on water use. Future land-use scenarios were evaluated for their effect on residential water consumption.[8]

Development Footprint

The main factor affecting water supply is the development footprint of the metropolitan area. This footprint is made up of surfaces such as buildings and paved roadways, which decrease the amount of land-area available for rainwater to permeate the surface and replenish ground water resources. Evaluating resiliency to drought, as it relates to changes in water supply, is determined by the amount of land developed in each scenario. It can be rationally assumed that scenarios with more acres of developed land are less resilient since they will place greater limits on ground water recharge.

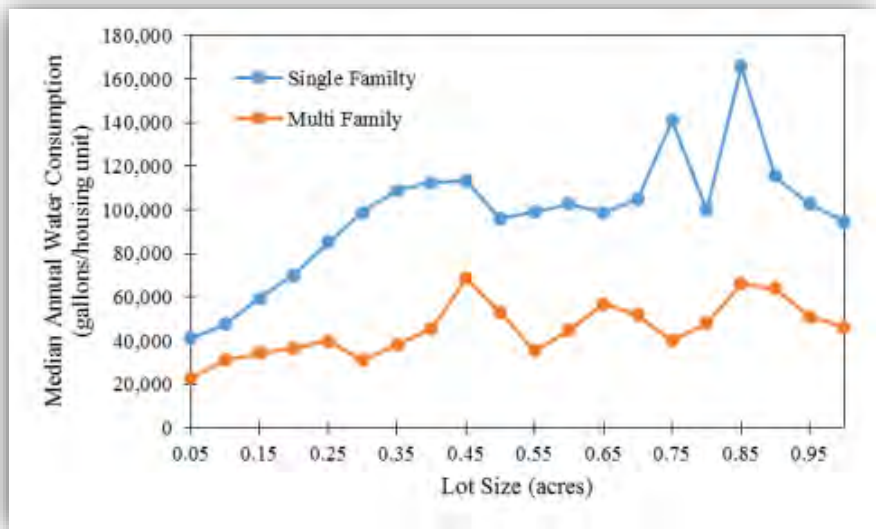
Lot Size and Water Use

At the same time, the main factor affecting water consumption is land use. The project team evaluated water consumption data from the Albuquerque Bernalillo County Water Utility Authority (ABCWUA) and the New Mexico Office of the State Engineer to create water consumption rates for each major category of land use. These water rates were then used to estimate the total water consumption of each scenario based on the amount of land developed by each land use category.

[8] Scenario analysis related to water demand was performed by the University of New Mexico as part of the Climate Change Scenario Planning Project. Much of the work in this section is taken directly from the final report developed for that project.

Figure 7-4: Residential Water Consumption Rates by Lot Size, Bernalillo County

Source: ABCWUA, UNM



Water use accounts were provided by the ABCWUA to determine how water consumption varied by land use, lot size, and year of construction. **Residential water consumption per housing unit increases as lot sizes increase. This trend is most notable for single family homes with less than half-acre lot sizes.**

As lot size increases above one-half acre, the association between lot size and water consumption decreases (the trend breaks down among larger lot sizes). The analysis indicates that single family housing units use far more water than multi-family housing units. Also, there is a sharp drop in water consumption rates for homes built after 2009. This is because lot sizes are getting smaller and tend to have less irrigated landscaping. Efficiency improvements may also play a role.

Trend vs Target Scenario

Due to the fairly strong correlation between lot size and water consumption rates, a per-acre water consumption rate was created to calculate overall residential consumption levels. These estimates are expected to provide a reasonable method for comparing the relative water consumption of each scenario. Scenarios that have lower land consumption rates are therefore expected to be more resilient to drought driven by climate change. Since the Target Scenario results in fewer acres required to meet residential housing needs than the Trend, the Target Scenario leads to lower annual water demands.

Table 7-2: Residential Acres and Total Water Consumed by Residential Users[9]

[In process of being updated]

[9] The residential water consumption rate (gallons/acre/year) is calculated at 421,085.

Transportation Investments and Smart Growth Strategies

The mode of transportation used, efficiency of traffic movement, as well as land use patterns each have important effects on air quality. Transportation investments that complement "smart growth" strategies address air quality regulatory requirements while positively influencing regional health and economic outcomes. According to the Environmental Protection Agency, smart growth is defined as **"a range of development and conservation strategies that help protect our health and natural environment and make our communities more attractive, economically stronger, and more socially diverse."**

Smart growth strategies which advance the Target Scenario and improve air quality include: [10]

1. **Mix Land Uses** – allow homes, offices, schools, parks, shops, restaurants, and other types of development to be built near one another—on the same block or even within the same building. This makes it possible for people to live closer to where they work or run errands, eliminating the need to drive for multiple daily needs.
2. **Take advantage of compact design** - make more efficient use of land that has already been developed by encouraging development to grow up, rather than out, or on empty and underutilized lots. Compact development reduces travel distance between destinations and makes the most of public investments in roads and other existing infrastructure.
3. **Create a range of housing opportunities and choices** - the housing options available in a community will influence a families' economic opportunities, costs of living, and how much time they spend commuting each day.
4. **Create walkable neighborhoods** - walkable places are created in part by mixing land uses and taking advantage of compact design but are activated by street design that makes walking not only practical but safe and convenient to enjoy.
5. **Preserve open space, farmland, natural beauty, and critical environmental areas** – in addition to the multiple benefits already mentioned in this chapter, the protection and expansion of vegetated areas effectively and naturally improves air quality.
6. **Provide a variety of transportation choices** - high-quality public transportation and safe, convenient biking and walking infrastructure makes alternatives to driving more attractive and reduces the number of polluting vehicles on the road.

The Target Scenario provides a list of Guiding Principles that are similar but have been vetted by regional stakeholders. They are as follows:

1. Coordinate land use and transportation planning.
2. Prioritize existing infrastructure.
3. Support active place-making.
4. Invest in activity centers and transit-oriented development.
5. Balance housing and jobs.
6. Create connected multi-modal networks.
7. Support premium regional transit.
8. Encourage diverse housing options.

[10] *What is Smart Growth?* Smart Growth America, 2019. www.smartgrowthamerica.org/our-vision/what-is-smart-growth. Accessed 19 November 2019

Low Impact Development (LID) and Green Stormwater Infrastructure (GSI)

LID is an approach to site design intended to reduce alterations to the natural, existing hydrology of land under development. LID encourages the use of permeable paving materials, and the clustering of buildings in a subdivision to maximize open space and reduce runoff volume by reducing the area of impervious surfaces like cement and asphalt. Impervious surfaces of streets and sidewalks alter existing hydrology, conveying stormwater runoff with erosive speed and a load of vehicular fluids which can pollute soils and waterways. GSI is a complimentary approach that provides effective ways to conserve and reuse water by using natural areas to slow it down, filter out pollutants, and allow stormwater to be used to feed vegetation and recharge the aquifer (see "Green Streets" in the LRTS Guide for more information).

Municipal and Developer Incentives

The benefits of LID are supported by the Environmental Protection Agency (EPA) in its Municipal Separate Storm Sewer System (MS4) requirements. City policies can either encourage or discourage the use of LID tools. Many cities have already adopted incentives for both public and private development to encourage increased LID. For the developer and builder, potential benefits might include expedited reviews, tiered fees, and even exceptions to certain planning requirements such as overall density, setbacks, parking, and landscaping. For homeowners, incentives might include rebates, cost savings from reduced landscape water use, and increased property values.

7.3 Air Quality Concerns

Due to rising population and employment in the region, total vehicle miles traveled in the AMPA is expected to increase considerably and directly to an increase in on-road vehicle emissions. These concerns are amplified by the possibility that ground level ozone concentrations will one day exceed National Ambient Air Quality Standards (NAAQS). Consequently, the AMPA must find methods to substantially reduce emissions and maintain healthy air quality into the future. It is important to note that today the region has generally good air quality. Ensuring this remains the case will be important for maintaining a high quality of life as well as meeting federal funding requirements for transportation projects.

Transportation Conformity and State Implementation Plans

Per the Clean Air Act, federally-supported transportation plans such as the MTP, transportation improvement programs (TIPs), and federal projects receiving federal funding in nonattainment or maintenance areas for a transportation related criteria pollutant (carbon monoxide, particulate matter, nitrogen dioxide, ozone) must conform to air quality State Implementation Plans (SIPs) and maintenance plans for getting back into attainment or staying in attainment for the NAAQS. Such plans and projects must demonstrate that they will not inhibit progress toward attainment or interfere with maintaining attainment. The process for making a formal finding of conformity to a SIP is known as a transportation conformity determination.

Generally, a transportation conformity determination is made through a process called "interagency consultation," which is prescribed in air quality regulation. It can require analysis to demonstrate that the total emissions projected for that plan or TIP are within the on-road mobile source emissions limits (also known as "budgets") established in the appropriate SIP. The decision about whether a transportation plan, program, or federally funded project meets criteria for a conformity determination rests with the AQCB, the MPO, EPA, FHWA and FTA. This decision is the affirmative written documentation declaring that the transportation plan conforms to the SIP's purpose of eliminating or reducing the severity and number of violations of the NAAQS and achieving prompt attainment of such standards.

MRMPO is currently in attainment for all the NAAQS and the limited maintenance period for carbon monoxide expired June 13, 2016. Thus, the MRMPO is not subject to the conformity determination requirements. No such determination is needed for adoption of the currently proposed MTP and TIP.

Congestion Mitigation Air Quality Funding (CMAQ)

Non-mandatory Congestion Mitigation Air Quality (CMAQ) funding is administered by the New Mexico Department of Transportation (NMDOT) and is available statewide for projects and programs that improve air quality and reduce congestion. NMDOT administers CMAQ on behalf of the Federal Highway Administration (FHWA). Pursuant to the FAST Act, transportation projects that fall into one of the following three broad categories are eligible for CMAQ funding.

1. Projects that reduce the number of vehicle trips and/or vehicle miles traveled (VMT);
2. Projects that reduce emissions related to traffic congestion; and/or
3. Projects that reduce the per mile rate of vehicle emissions through improved vehicle and fuel technologies.

For more details on the Congestion Mitigation Air Quality Program, please refer to the *NMDOT FFY 2020 Congestion Mitigation and Air Quality (CMAQ) Improvement Non-Mandatory Program Guide.*

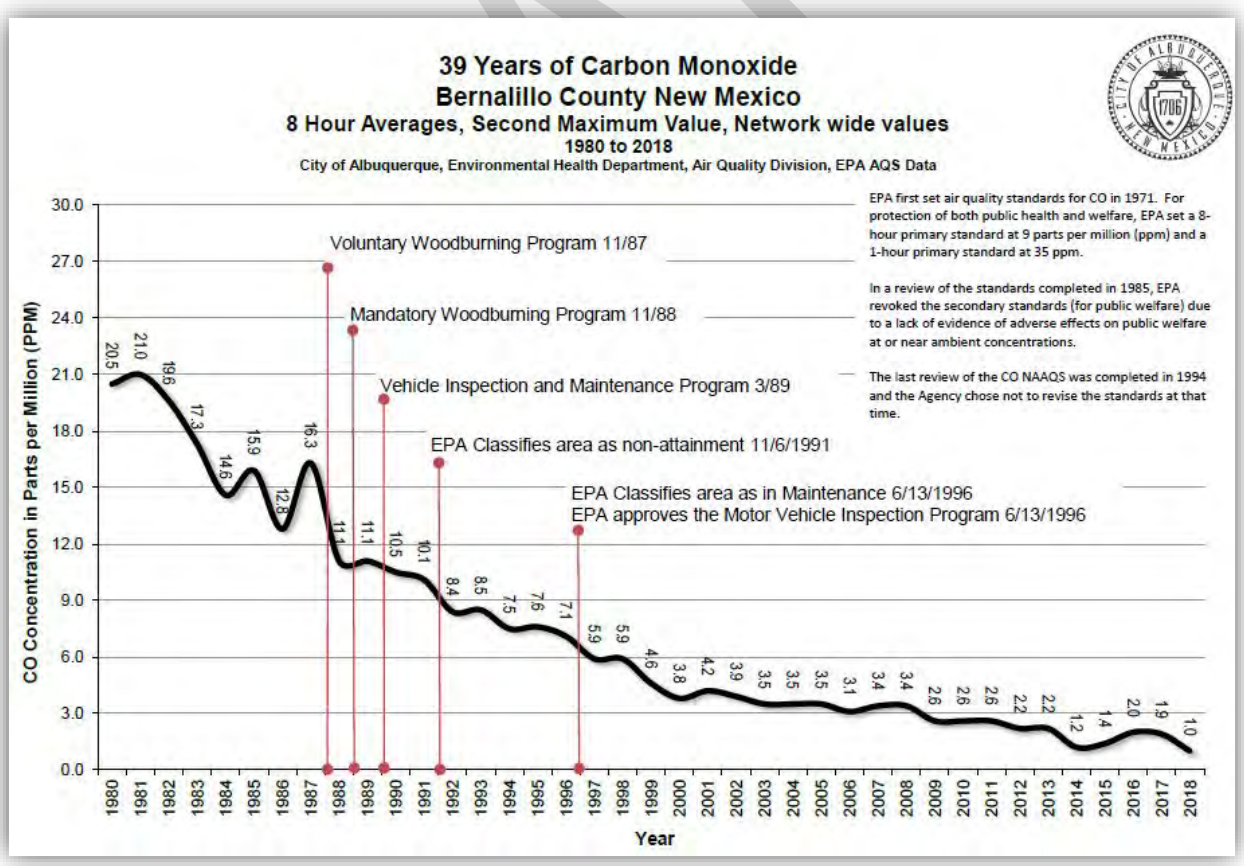
Air Quality Monitoring

Air quality is monitored within Bernalillo County by the City of Albuquerque Environmental Health Department, Air Quality Program. For all other areas within the AMPA that are outside of Bernalillo County, air quality is monitored by the New Mexico Environment Department, Air Quality Bureau. Areas are designated as attainment or nonattainment according to whether they meet NAAQS for each criteria pollutant based on collected monitoring data. NAAQS are federal standards that establish an air quality concentration to protect public health and welfare. The NAAQS are set for six principal pollutants also known as criteria pollutants. The six criteria pollutants are Ozone (O3), Nitrogen Dioxide (NO2), Carbon Monoxide (CO), Particulate Matter (PM2.5 & PM10), Sulfur Dioxide (S02), and Lead[11].

Air Quality in the AMPA

Since Bernalillo County was designated in nonattainment of the carbon monoxide (CO) standard in the early 1990s, no subsequent nonattainment designations for any federal air quality standards regulating the six criteria pollutants promulgated by the U.S. Environmental Protection Agency (EPA) have occurred within the AMPA. With respect to CO, the Albuquerque - Bernalillo County Air Quality Control Board (AQCB) adopted a State Implementation Plan (SIP) for reaching attainment that included several effective control strategies that have brought the area into compliance status. The plan was a great success. Not only did the area reach attainment but in fact CO levels have continued to stay well below the standards.

Figure 7.5: Carbon Monoxide in Bernalillo County, 1980-2018



[11] Since sources of lead are virtually non-existent in the city/county area, the EPA has approved an exception to area monitoring requirements for this pollutant.

The 2019 design value[12] for CO, based on the latest quality-assured data available at this time, is 1.1 parts per million (ppm) for the 8-hour CO NAAQS and 2.2 ppm for the 1-hour CO NAAQS. These values represent 11.7 percent and 6.3 percent of the relevant standards, respectively.

Limited Maintenance Plan

Under the recently expired Limited Maintenance Plan (June 2016), the MTP had conformed to other requirements, including interagency consultation, financial constraint, a minimum 30-day public comment period for the plan, and other federal planning requirements. The FHWA, in consultation with the EPA, had determined that the current 2040 MTP for the Albuquerque Metropolitan Area met those requirements and therefore is in conformance with the former Limited Maintenance Plan. Should the region fall into non-attainment for other regulated air pollutants in the future, MRMPO will work closely with all stakeholders and outline all necessary steps and requirements it must perform to obtain conformity within this document and subsequent MTPs and any applicable State Implementation Plan (SIP).

Future Ozone and Transportation Conformity Issues

The next concern on the horizon is ground level ozone. Ozone near the Earth's surface is a type of pollutant not directly emitted, but instead produced by a complex chemical reaction between ozone precursors in the presence of sunlight and heat. Principal among the ozone precursors are volatile organic compounds (VOCs) such as raw fuel vapors and oxides of nitrogen (NOx) formed primarily during the combustion of fossil fuels. The primary control of ozone formation is based on regulating emissions of volatile organic compounds and oxides of nitrogen. Since ozone does not form immediately, and because heat and sunlight are actors in its creation, ozone can form miles away from the original source of its precursors and forms more readily during the hot summer months. As elevated temperatures directly increase the rate of ground-level ozone formation, and the primary source of electrical energy in the region is coal-burning power plants, global warming will further exacerbate this effect by increasing demand for energy needed to cool homes and businesses.

National Ambient Air Quality Standard (NAAQS)

The current National Ambient Air Quality Standard (NAAQS) for ground level ozone is 70 ppb[13], which is where measurements for the Albuquerque metro area currently register (100% of the NAAQS). Since the level is not yet exceeded, the area is in attainment at this time. The EPA has progressively lowered the ozone standard over time: to 80 ppm in 1997, 75 ppm in 2008, and 70 ppm in 2015, and is projected to decide on a revised standard in October of 2020. Should the standard be lowered, or ground level ozone levels increase beyond current concentrations, that would result in Bernalillo County and other parts of the AMPA exceeding the standard. This could lead EPA to designate the area in nonattainment, triggering the need for a SIP that delineates how the area proposes to reach attainment status. The nonattainment status and subsequent submittal of a SIP would have an impact on how federally funded transportation projects in the region are evaluated with regard to conformity to the SIP. In the meantime, the region can take steps to minimize transportation-related emissions, including analyzing the air quality impacts of transportation projects, and implementing mitigation strategies included here in the MTP.

[12] "Design value" is a measurement of the ambient air concentration of a pollutant over time. This measurement must be approved by the EPA and must use EPA-approved monitoring methods.

[13] A more complete statement of the standard is that ozone concentrations must not exceed 70 parts per billion, calculated by obtaining the annual fourth-highest daily maximum 8-hour concentration, averaged over three years. Complete details on the standard can be found in EPA's Federal Register publication promulgating the ozone NAAQS, Federal Register volume 80, no. 206, October 26, 2015, page 65,332.

Ozone Public Awareness Campaign

The City of Albuquerque Environmental Health Department has initiated a campaign to raise awareness of causes and remedies for ground level ozone. Individual choices in our region can have a positive impact on ozone pollution. Examples of what each of us can do to improve reduce emissions that cause ozone include:

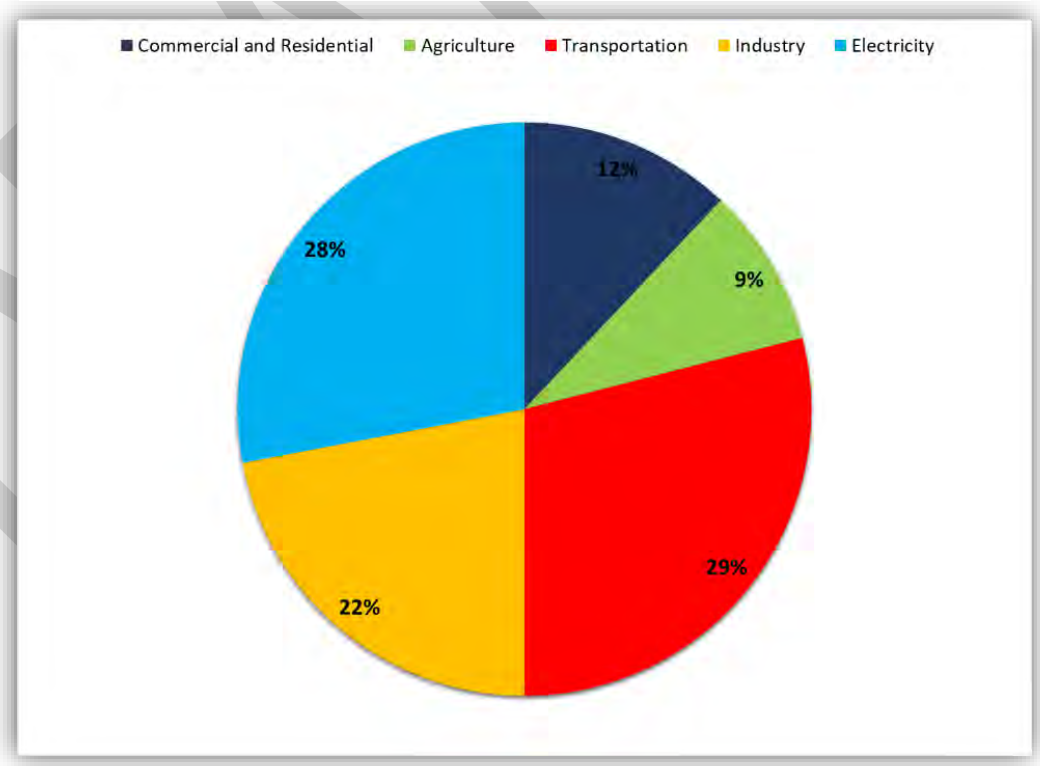
- Conserving electricity at home and work
- Walking, biking, carpooling, or using transit to get around
- Refueling your vehicle when cooler temperatures to reduce VOC emissions from the gas pump
- Turning off your engine when waiting in line at a drive-through or picking up the kids from school
- Keeping your car tires inflated because better gas mileage means reduced exhaust
- Driving the speed limit

For more on how you can help prevent ozone formation, go to www.cabq.gov/ozone.

Greenhouse Gases

Greenhouse gases (GHGs) enter the atmosphere through the burning of fossil fuels, as well as certain industrial processes and land use practices, but they differ from other emissions in that GHGs also trap heat in the atmosphere. **Over 90 percent of the fuels burned for transportation are petroleum based, and the transportation sector of the economy is the leading source of climate-disrupting greenhouse gas emissions in the United States.** [14] CO_2 is 97 percent of the total GHG emissions produced by transportation.[15] Like all other communities across the world, the Albuquerque metropolitan area must consider ways to reduce global carbon dioxide (CO_2) emissions, which is the primary greenhouse gas created through human activity.

Figure 7.6: US Greenhouse Gas Emissions by Sector, 2017



Transportation Sector

Roughly equaling the energy sector in U.S. contributions, transportation produces 29 percent of the nation's GHG emissions and therefore represents an important opportunity for curbing global climate change. The on-road sources of GHGs include automobiles, buses, trucks, and other vehicles traveling on local and highway roads. While reducing GHG emissions from these

[14] Sources of Greenhouse Gas Emissions, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions
[15] Fast Facts: U.S. Transportation Sector Greenhouse Gas Emissions, 1990-2017. EPA-420-F-19-047, June 2019

sources positively impacts climate change outcomes, many of the strategies for reducing these emissions are also beneficial in addressing other transportation-related pollution from carbon monoxide (CO), fine particulate matter (PM2.5), and ozone precursors. Therefore, for the region to play its role in reducing GHG emissions also means addressing local air quality.

Fuel Efficiency Standards

The decline in per capita GHG emissions is driven in part by previously adopted federal regulations of the DOT's National Highway Traffic Safety Administration (NHTSA) to require increases in average fuel efficiency for new vehicles nationwide (Corporate Average Fuel Economy standards).[16]

However, in August of 2018 the EPA and NHTSA issued a proposed rulemaking entitled "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule" that, if enacted, would freeze the CAFE standards for model year 2021-2026 light duty vehicles to the 2020 target of 37 mpg (previously 54 mpg by 2025) and halt requirements on the production of hybrid and electric cars. It would also revoke the legal waiver of the Clean Air Act issued to California in 2013 allowing it to set more stringent standards for tailpipe GHG emissions and establish mandates for Zero Emission Vehicles (ZEV) in order to establish a uniform national program for GHG and fuel economy standards. If implemented, these changes would likely affect future air quality scenarios for the AMPA. Whether the planned rules materialize is a key concern for the future.

In 2019 a coalition of California and 22 other states (including New Mexico) filed a lawsuit challenging this Trump administration effort to revoke independent state authority. If successful, Governor Michelle Lujan Grisham has announced plans for New Mexico to set its own fuel economy and pollution standards beginning with model-year 2022 cars, pickup trucks, and SUVs, with a planned increase to an average of 52 mpg by 2025. If the state adopts such a regulation, the Albuquerque - Bernalillo County Air Quality Control Board will be required under state/federal law to do the same.

VMT Per Capita

Vehicles miles traveled (VMT) per capita declined in the previous MTP but has since started going up again after the impacts of the 2008 recession have worn off some. Unless VMT declines again, other strategies for reducing emissions need to be advanced like changes in land use configurations that result in shorter travel distances and an emphasis on alternative modes of transportation that produce either zero emissions or relatively small amounts of emissions per capita (e.g., public transit service).

According to the Transportation Research Board's *Driving and the Built Environment:*

> "The greatest opportunities for building more compact, mixed-use developments (and therefore reducing travel demand and GHG emissions) are likely to lie in new housing construction and replacement units in areas already experiencing density increases, such as inner suburbs and developments near transit stops and along major highway corridors or interchanges."[17]

Figure 7-7: Change in Emissions by Scenario, CO_2 tonnes per day (Trend vs Target)

[In process of being updated]

[16] Fleet average fuel efficiency is calculated by dividing each scenario's estimated daily CO2-equivalent emissions by daily VMT. CO2-equivalent was estimated by MOVES and considers changes in the vehicle fleet, distribution of VMT by roadway type, and traffic speed. VMT was estimated by MRCOG's travel demand model.

[17] Transportation Research Board, *Driving and the Built Environment*, Special Report 29, Washington DC, 2009

Emission Free Vehicles

Primarily electrically powered, emission free, or zero emission vehicles (ZEVs) are designed to generate fewer global warming emissions than gas powered cars and emit no tailpipe pollution. Initiated in California in 2012 and later adopted in ten other states, the Zero Emission Vehicle (ZEV) program requires in-state automakers to sell electric cars and trucks. The program's objective is to ensure that automakers research, develop, and market electric vehicles. Thanks in large part to this policy, over 40 zero emission models are available to the public in 2019. Three distinct vehicle designs are considered "zero emission" (to varying degrees):

- Plug-in hybrid vehicles - combining a conventional gasoline-powered engine with a battery that can be recharged from the electrical grid.
- Battery electric vehicles - running entirely on electricity and which can be recharged from the electricity grid.
- Hydrogen fuel cell vehicles - running on electricity produced from a fuel cell using hydrogen gas.[18]

As an increasingly available option for consumers, the extent of their adoption regionally may produce a significant shift in future air quality and GHG projections. Their development also has important implications for transportation infrastructure development needs. For example, electric vehicle (EV) charging stations will be needed near enough to one another to allow drivers to reach them before batteries run down on long distance journeys.

Alternative Fueling and Charging Infrastructure

Anticipating this need, the Federal Highway Administration (FHWA) has since 2016 been supporting the establishment of a national network of alternative fueling and charging infrastructure along the national highway system through its Alternative Fuel Corridor designation program. The goal is to support the expansion of this national network through a process that:

- provides the opportunity for formal corridor designations on an annual basis;
- ensures that corridor designations are selected based on criteria that promote the "build out" of a national network;
- develops national signage and branding to help catalyze applicant and public interest;
- encourages multi-State and regional cooperation and collaboration; and,
- brings together a consortium of stakeholders including state agencies, utilities, alternative fuel providers, and car manufacturers to promote and advance alternative fuel corridor designations in conjunction with the Department of Energy.[19]

Currently, there are no designated alternative vehicle corridors in New Mexico, despite pending nominations in all neighboring states on shared Interstate highways. The Energy Conservation and Management Division's recent Energy Roadmap plan includes the goals of increasing alternative fuel infrastructure and the availability of AFV's and related maintenance services. FHWA data indicate only 3 electric fast charging stations in the MRCOG region, out of 11 in the state, but according to data provided by the City of Albuquerque, there are currently 133 EV charging facilities located in the City.

[18] https://www.ucsusa.org/resources/what-zev

[19] https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/

Figure 7-8: Energy Roadmap for the Southwest

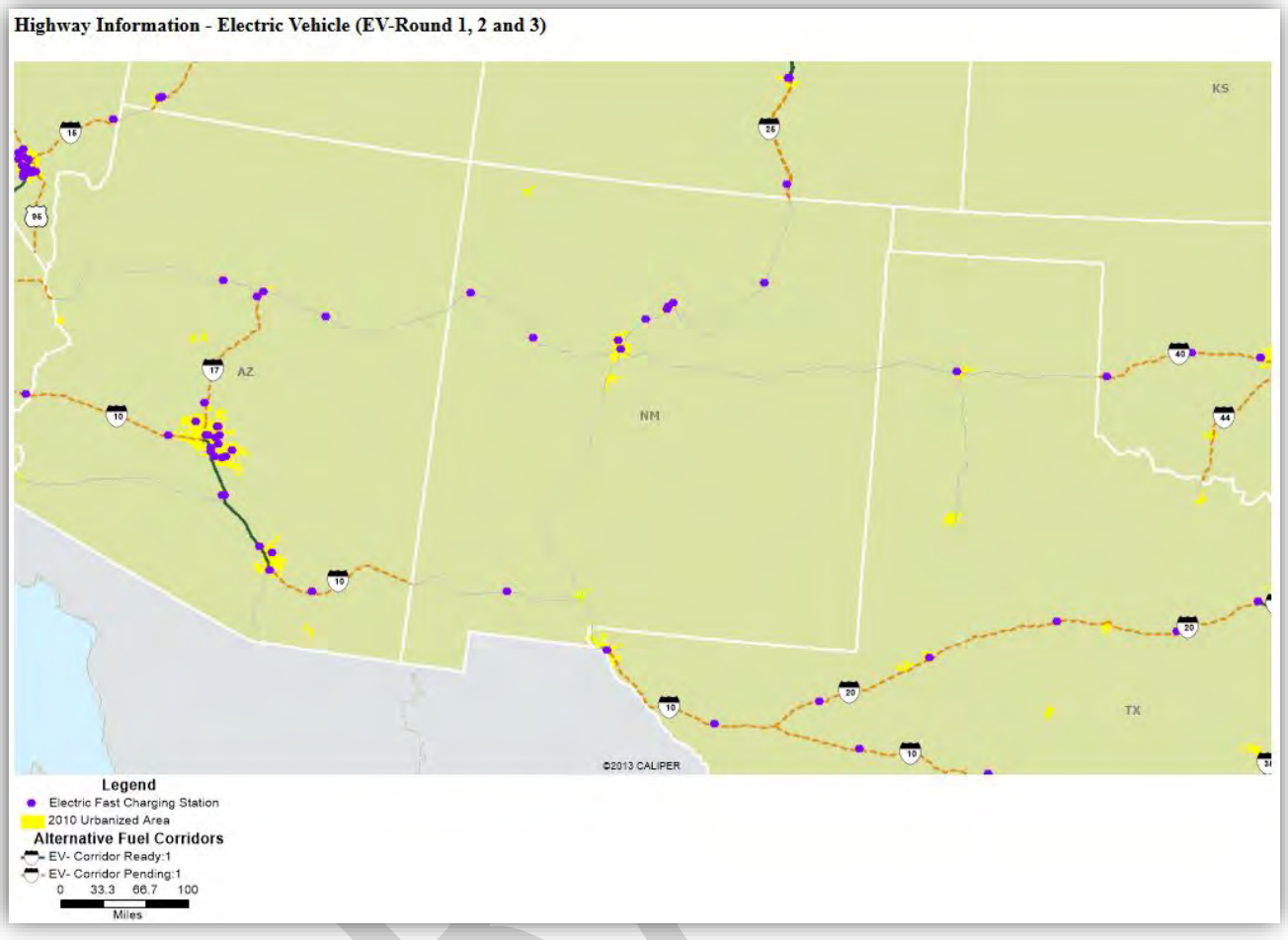
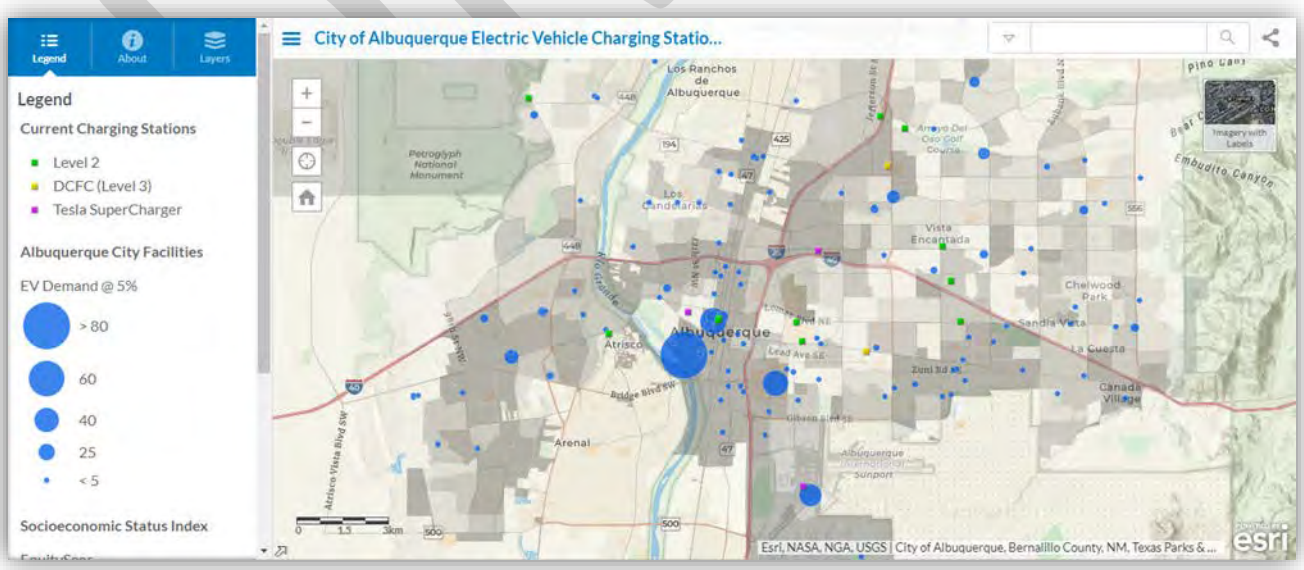


Figure 7-9: City of Albuquerque Electric Vehicle Charging Stations

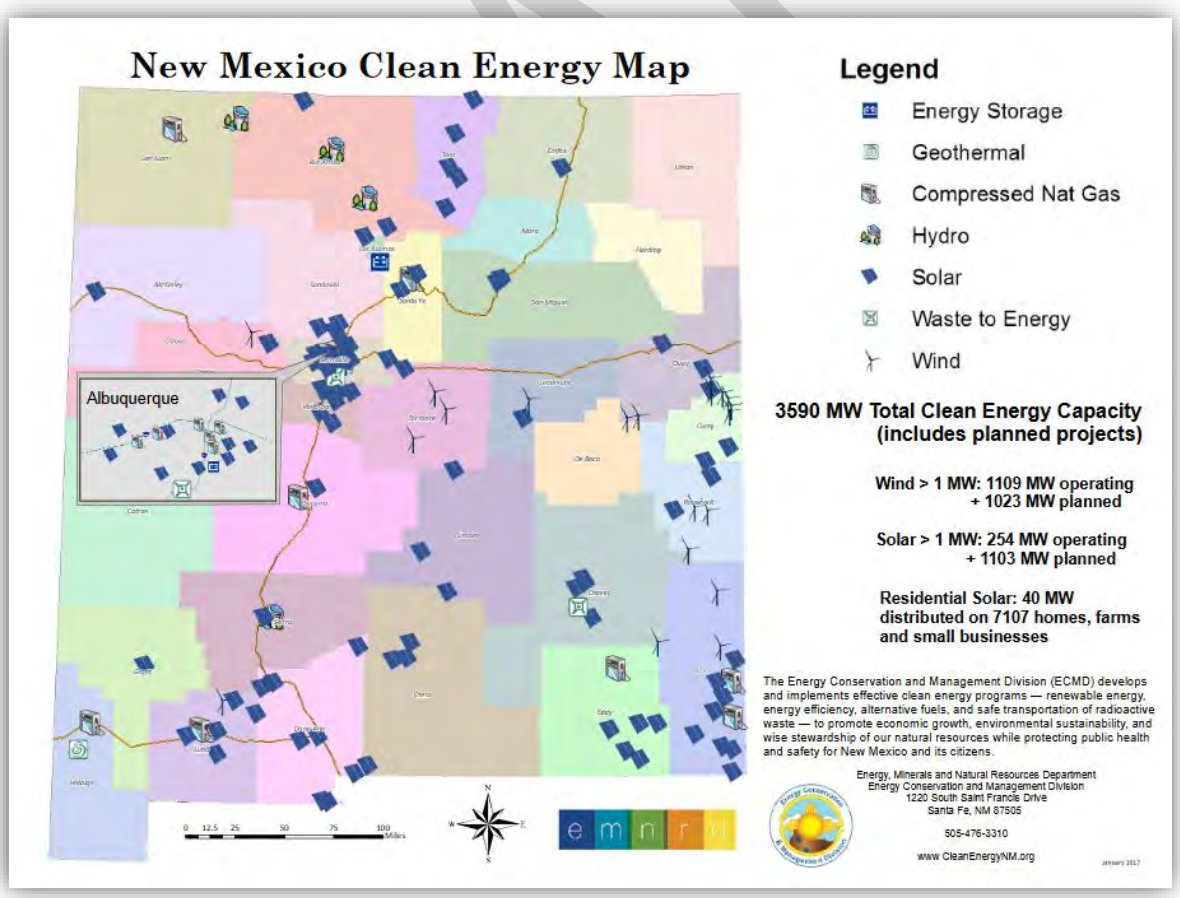


Clean Energy

While electric vehicles have clear benefits for regional air quality, their GHG emissions are primarily shifted over to the energy sector. Aside from household solar panel systems, the Public Service Company of New Mexico (PNM) is the lone provider of electricity for the region, and until recently, coal-burning was their primary power source. Ownership interests in coal fired power plants totaled 983 MW at the end of 2017, but after retiring two units of the San Juan Generating Station, fell to 762 MW in 2018. PNM has proposed reducing coal fired resources further, such that by 2023 it would only own 200 MW, and be coal-free in 2032. PNM has worked to significantly reduce emissions over the past 15 years through the installation of additional pollution control technologies, the increased use of renewable energy and natural gas, and the development of extensive energy efficiency and conservation programs for customers, and current plans are to be completely GHG emissions-free by 2040.

Supporting this monumental shift is the March 2019 passage of the Energy Transition Act, Senate Bill 489, a landmark legislation which sets a statewide renewable energy standard of 50 percent by 2030 for New Mexico investor-owned utilities and rural electric cooperatives and a goal of 80 percent by 2040, in addition to setting zero-carbon resources standards for investor-owned utilities by 2045 and rural electric cooperatives by 2050. The bill provides for tens of millions of dollars in economic and workforce support for communities impacted by coal plant closures, as well as the development of renewable replacement power in San Juan County.

Figure 7-10: New Mexico Clean Energy Map



Central New Mexico Climate Change Scenario Planning Project

Considerable work was performed through the *Central New Mexico Climate Change Scenario Planning Project* to identify potential transportation and land use strategies that could result in GHG emissions reductions, as well as the magnitude of that impact. These strategies, especially when used in combination, could have meaningful impacts on congestion management outcomes and reductions in per-capita vehicle emissions in the region. The full list of strategies is included in Chapter 9. Examples include Travel Demand Management and expanded transit service.

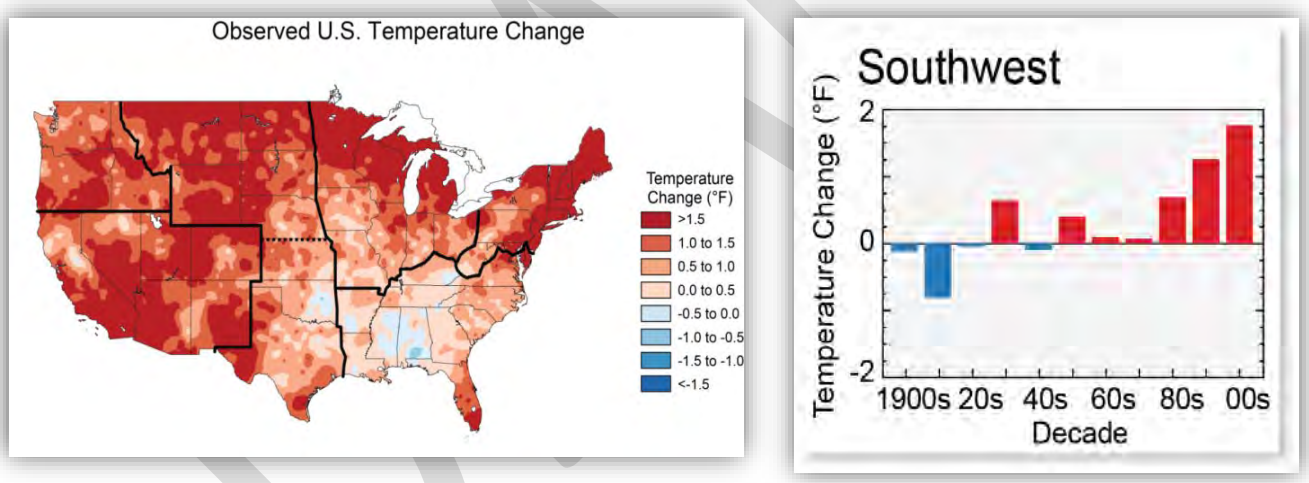
7.4 Climate Change Projections

In 2013 the Mid-Region Council of Governments was awarded a federal grant to incorporate climate change considerations into its transportation planning process. It was through the expanded scope made possible by the Central New Mexico Climate Change Scenario Planning Project, and the resulting partnerships, that climate change issues were first discussed in the *Futures 2040 MTP*.[20] This climate change project and related analysis is still timely, particularly as changing temperature and precipitation levels are expected to lead to increased risk of wildfires, flooding, and heat-related illness and deaths. This chapter gives emphasis to preparing for and mitigating the impacts of these natural hazards.

a. Temperature and Precipitation Changes

The effects of climate change on temperatures in central New Mexico are particularly acute. Over the period of 1971 through 2011, average temperatures in the Upper Rio Grande Basin, in which the AMPA is situated, rose at a rate of just under 0.7°F per decade, approximately double the global rate of temperature rise.[21]

Figure 7-11: Observed U.S. Temperature Change, 1901-2012; Observed Temperature Change Decadal Bar Graph, 1900s-2000s, U.S. Southwest[22]



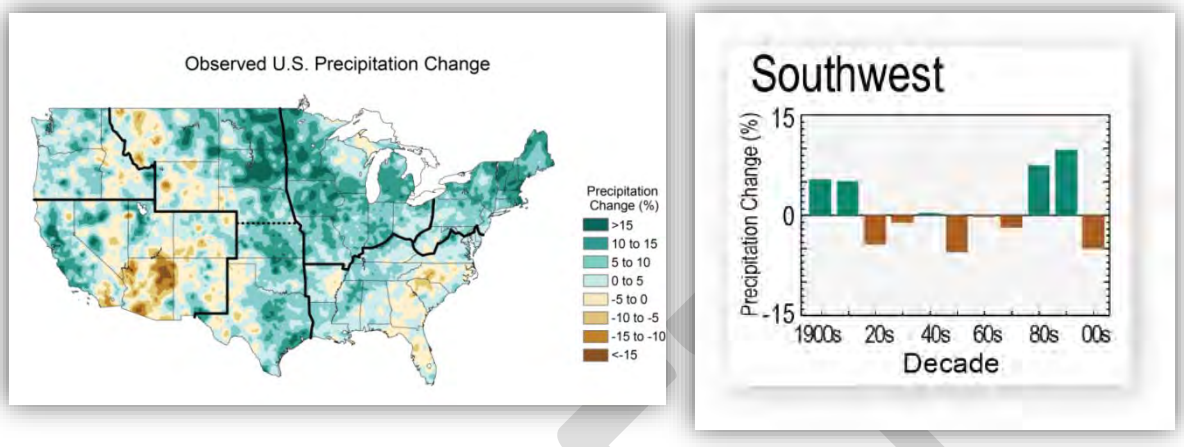
Annual precipitation is slightly more likely to decrease than increase, but perhaps only by a small margin. **The true impact of changes in precipitation will be felt in the variability.** Climate experts anticipate that central New Mexico is likely to experience increased frequency of droughts, followed by increasingly extreme precipitation events. As a result, annual precipitation may not change greatly, but the nature of precipitation *is* expected to change.

[20] The following federal agencies provided funding and/or technical assistance for the Central New Mexico Climate Change Scenario Planning Project: the Federal Highway Administration, U.S. Department of Transportation Volpe Center, U.S. Fish and Wildlife Service, Bureau of Land Management, U.S. Army Corps of Engineers, Bureau of Reclamation, National Park Service, U.S. Forest Service, Federal Transit Administration, Federal Emergency Management Agency, Department of Homeland Security, , and the Environmental Protection Agency. For more information, please see the "Climate Change Project" link on the MRCOG website.

[21] Bureau of Reclamation, *Upper Rio Grande Impact Assessment*, Executive Summary, S-iii

[22] U.S. Global Change Research Program www.globalchange.gov

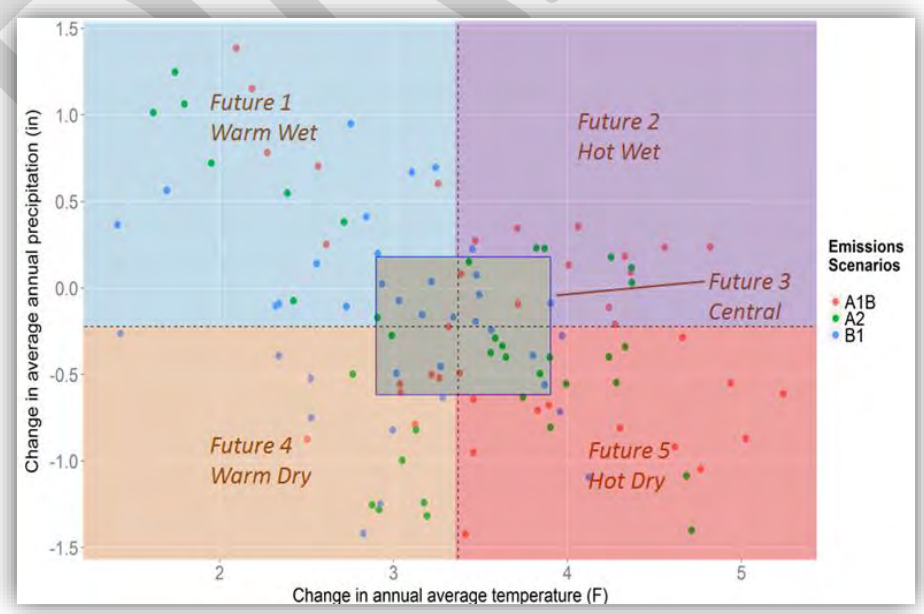
Figures 7-12: Observed U.S. Precipitation Change, 1901-2012; Observed Precipitation Change Decadal Bar Graph, 1900s-2000s, U.S. Southwest[23]



b. Climate Futures in the Albuquerque Area

Detailed analysis on expected climate change impacts in the Albuquerque metropolitan area were conducted as part of the Central New Mexico Climate Change Scenario Planning Project. Potential changes in temperature and precipitation identified by general circulation models using three emissions scenarios.[24] The data can be grouped into four climate scenarios, or climate futures, as well as a central tendency value based on data points between the 25th and 75th percentile. The most common grouping, or central tendency characteristics, indicates that average annual temperatures will increase 3-4°F by the year 2040. In addition to greater overall average temperatures, the number of days with temperatures over 100°F is also expected to increase.

Figure 7-13: Change in Annual Temperature and Precipitation Levels, Summary of Global Circulation



[23] U.S. Global Change Research Program www.globalchange.gov

[24] Data analysis conducted by US DOT Volpe Center following a methodology employed by Bureau of Reclamation and Sandia National Labs for the *Upper Rio Grande Impact Assessment.* CMIP3 data was utilized for this analysis.

Extreme Heat and Health

Heat is responsible for more fatalities per year on average than any other weather-related hazard in the United States, according to the National Weather Service. Recent epidemiologic findings on heat related health impacts have shown a range of impacts on morbidity outcomes including cardiovascular, respiratory, and even mental health responses. Further, heat causes undesirable side effects of psychiatric medications.[25] The homeless, elderly, obese, diabetic, and the very young are all especially vulnerable to heat-related illness and death. Urban areas are particularly vulnerable to the impacts of heat, since they concentrate large numbers of vulnerable people in settings where ambient temperatures are often higher than suburban and rural areas due to the "urban heat island" effect.

Urban Heat Islands

Urban Heat Islands (UHI) are where the concentrated energy of people, vehicles, and manmade materials in urban environments combine to make ambient air temperatures more extreme than in surrounding areas, and nighttime temperatures remain high for longer periods of time. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F (1–3°C) warmer than its surroundings. In the evening, the difference can be as high as 22°F (12°C).[26]

During extreme heat events, which are exacerbated by urban heat islands, the resulting demand for cooling can overload power distribution systems and require a utility to institute controlled, rolling brownouts or blackouts to avoid power outages. Those without access to effective indoor temperature control are then made more vulnerable to heat-related health effects**. Planting trees for shade and other vegetation for cooling via evapotranspiration are the most effective means of mitigating UHI.** Sharing many of the benefits associated with green infrastructure as a whole, the "triple bottom line" (economic, ecologic, and social) benefits of healthy urban trees are enormous and bear repeating. Research has linked the presence of urban trees to:

- Increasing neihborhood property values
- Filtering up to a third of fine particle pollutants within 300 yards of a tree
- Protecting biodiversity – including habitat for migrating birds and pollinators
- Reducing obesity levels by increasing physical activities like walking and cycling
- Reducing rates of cardiac disease, stroke, and asthma due to improved air quality
- Managing stormwater – keeping pollutants out of waterways and reducing urban flooding
- Cooling city streets by 2-4 degrees fahrenheit – reducing deaths from heat and cutting energy use

In addition, a growing body of research points to "intra-urban" heat islands, or areas within a city that are hotter than others due to the uneven distribution of heat-absorbing buildings and pavements, and cooler spaces with trees and greenery. These differences can result from disparities in the way communities are planned, developed, and maintained.[27] There are often correlations between hotter neighborhoods and demographic characteristics of residents, with factors such as race and income often playing a role in who bears the brunt of extreme heat.

[25] Petkova, Elisaveta P et al. "Health impacts of heat in a changing climate: how can emerging science inform urban adaptation planning?." *Current epidemiology reports* vol. 1,2 (2014): 67-74. doi:10.1007/s40471-014-0009-1

[26] U.S. Environmental Protection Agency. "Heat Island Effect." EPA.gov/heat-islands. Accessed November 25th, 2019

[27] U.S. Environmental Protection Agency. "What is the Heat and Equity Connection?" EPA.gov/heat-islands/heat-islands-and-equity. Accessed December 4th, 2019

Albuquerque Metro Area Tree Canopy

As part of its Urban Conservation Program, the Nature Conservancy conducted an inventory of the Albuquerque metro area tree canopy, which in 2018 was found to cover only 10% of the total area, and being lost at the third highest rate in the nation.[28] Recently, a new effort led by the Albuquerque City's Parks and Recreation Department is refocusing its efforts to create an effective program to support a thriving urban forest. A challenge was also issued to Albuquerque residents to help plant at least one tree for every kid, with the goal of planting 100,000 trees around the city in the next ten years. The below map uses Light Detection and Ranging (LiDAR) technology to identify where the tree canopy is lacking in relation to populations most vulnerable to extreme heat to provide a potential means of prioritizing locations for new tree plantings, parks, and green infrastructure interventions.

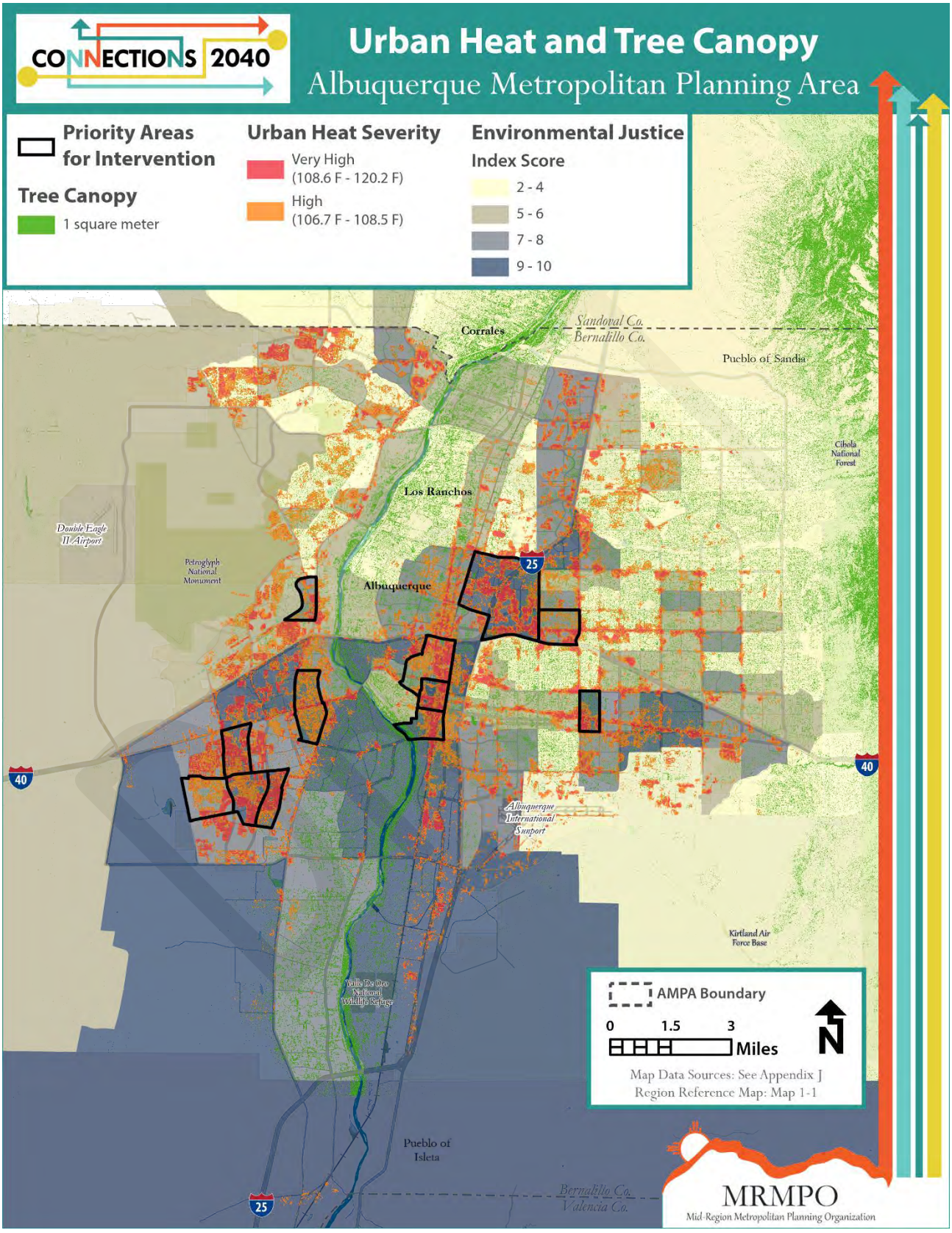
The map below combines data provided by the Trust for Public Land's Urban Heat Island analysis[29] performed as part of the Greenprint initiative with Bernalillo County and tree canopy inventory by the Nature Conservancy[30] with 2018 ACS 5-year Census data to identify areas where heat severity and vulnerability overlap to identify priority locations for new tree plantings, parks, and green infrastructure interventions. Generally the map shows that the hottest areas of the urban environment are where the area of tree canopy is low and areas of impervious surface are high, as expected.

[28] Hurteau, Sarah and Miller, Amy. "The Importance of Tree Canopy in Urban Conservation." The Nature Conservancy presentation to the City of Albuquerque Air Quality Control Board, February 14, 2018. cabq.gov/airquality/air-quality-control-board/documents/03-tree-canopy-presentation.pdf. Accessed November 25th, 2019.

[29] Generated from LANDSAT Satellite Sensory Data of land surface temperatures in June and August of 2014 and 2015 plus National Land Cover Dataset impervious surface estimates, to create a scaled overlay representing extreme heat areas.

[30] Mapped from 4-band 1-meter resolution aerial photographs captured in the summer of 2016 by the National Agriculture Imagery Program (NAIP) using a Classification and Regression Trees (CART) classifier and hand digitized training data in Google Earth Engine (GEE).

Map 7-4: UHI and Tree Canopy in the Albuquerque Metro Area



c. Natural Hazards

Expected impacts to the built environment were discussed in a report produced for the climate change project by Ecosystem Management, Inc. (EMI).[31] Runoff from flooding events in conjunction with forest degradation due to increased forest fires will be increasingly problematic. Concentrations of nitrogen, phosphorus, suspended solids, and salt may increase as soil qualities degrade in response to increased evaporation rates for surface water and increased precipitation intensity. **This would ultimately create a greater volume of pollutants in the river, with potential consequences for water quality.** There is also evidence that precipitation events may become more extreme, meaning rainfall events that may have had a one percent annual probability (i.e. a 100-year design storm) may occur more frequently. Some of the report's findings are summarized below.

Droughts

Droughts will have a range of impacts to humans and to the natural environment. Extended periods between rainfall events can impact the viability of local vegetation, reduce habitat for aquatic fish and bird species, and impact land animals in the surrounding riparian zones. Drought patterns may therefore require more water to support existing activities and ultimately necessitate adaptation in farming techniques and the types of agricultural products that may be produced. Taking care of soil quality around the region improves drought resilience by increasing the ability of soils to retain water.

Wildfires

Increased periods without rainfall can also increase the risk of wildfires. While forest fires are a natural part of the landscape, the frequency and ferocity of events has increased dramatically in recent years. In fact, 19 of the 20 largest recorded wildfires in New Mexico have occurred since 2000. The State of New Mexico Energy, Minerals & Natural Resources Department, Forestry Division lists 305 fires in Bernalillo County from August 10, 1993, to August 10, 2004, with more than 5,000 acres burned. Two wildfires along the Rio Grande in the summer of 2003 cost the State, City, and County almost $14 million, burning nearly 400 acres, and resulting in the temporary closure of Interstate 40.[32] Such events are likely to continue, with impacts on the health of forest lands and greater threats to the built environment.

Flooding

Extreme precipitation events that follow periods of prolonged drought also create the conditions for flooding events, which may become more extreme with climate change. New Mexico has a long history of flash flooding problems. Many minor flash flood events occur each year during New Mexico's summer monsoon season. Bernalillo County has suffered damage from numerous major floods and localized flash flooding since 1893. Flood control infrastructure will be more burdened and likely need supplementation in the future, even as overall water supplies decrease.

Exposure and Mitigation

Ultimately, how the region grows and its ability to adapt to climate change impacts are interrelated. Minimizing growth in at-risk locations requires development forms that also lead to better transportation outcomes, a smaller regional footprint, and lower levels of water consumed for residential purposes. The Central New Mexico Climate Change Scenario Planning Project allowed MRMPO and regional stakeholders to incorporate these impacts into long-term regional-scale analyses.

[31] EMI, "Climate Changes Effects on Central New Mexico's Land Use, Transportation System and Key Natural Resources," 2014, available on the MRCOG website.

[32] https://www.bernco.gov/uploads/FileLinks/1470d2e55af641018c84db709d9a9ab4/bernalillo_county_base_EOP.pdf

Of interest was the relationship between future development patterns and vulnerabilities to the effects of climate change. Five climate change-related components were considered through the scenario planning process and evaluated using performance measures. Some of these have already been discussed, but in total included the following components:

- High flood risk areas: level of development in FEMA-designated 100-year floodplains
- Forest fire risk areas: level of development in wildland-urban interface areas
- Crucial habitat areas: level of development in high ranking areas using the Western Governors' Association Crucial Habitat Assessment Tool
- Water consumption: number of gallons of water consumed by residential users per year
- Emissions levels: CO_2 tonnes per day

Two of these factors are considered in this section: flood-risk areas and forest fire risk areas. Of interest, from a scenario planning perspective, is whether emphasizing development in certain locations, such as generally low-risk activity centers, can result in decreased levels of development in at-risk locations. Since these measures lend themselves to spatial analysis, it is possible to observe the differences between the current and future year conditions and the extent to which households and other structures interact with these vulnerable locations. In this way the Trend and Target Scenarios can be evaluated for their relative resiliency to climate change impacts.

Flood Risk Areas

FEMA designates 100-year floodplains based on the extent of impact likely from a 24-hour 100-year precipitation event. In the AMPA, floodplains are generally located along the Rio Grande and arroyos that flow into the river system. As the frequency and intensity of extreme events (i.e., the 100-year design storm) are projected to increase and impervious surfaces associated with new development expand to cover more ground and increase runoff volumes, individual floodplains will likely be enlarged, but FEMA-designated floodplains are the currently official tool for assessing the risks associated with extreme precipitation events across the region.[33] The *Connections 2040 MTP* therefore uses the floodplains for spatial analysis and considers the number of housing units plus employees located in existing floodplains for the 2016 base year, Trend, and Target Scenarios.

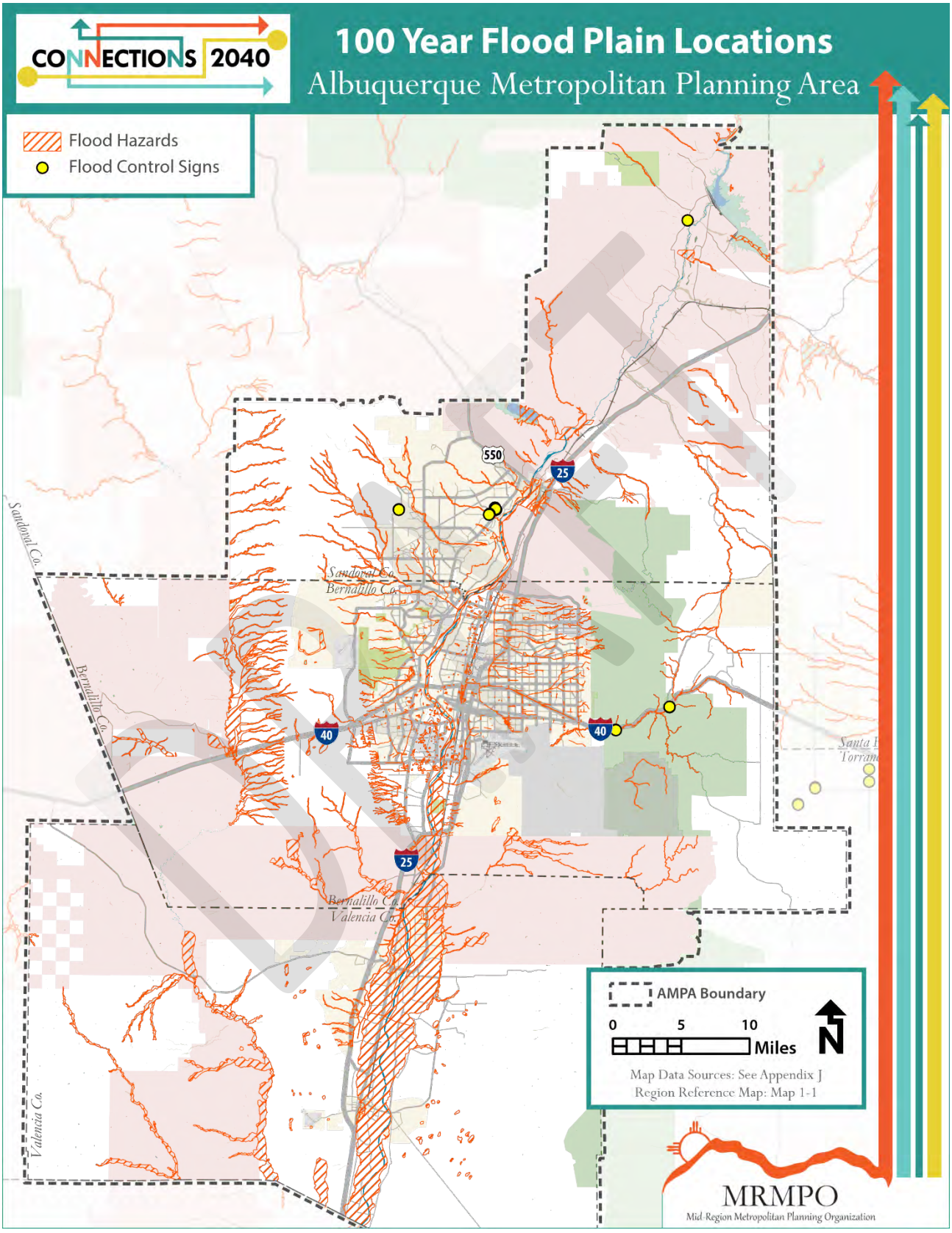
Table 7-3: Employment plus Households in Vulnerable Locations

[In process of being updated]

Location	2016	Trend	Preferred
FEMA 100-Year Floodplains			
Wildland-Urban Intermix areas			

[33] The Southern Sandoval County Arroyo Flood Control Authority performed a detailed analysis of the potential change in peak flow associated with increases in the 100-year design storm event for the Calabacillas Arroyo. SSCAFCA found that 10 percent increase in the design-storm resulted in a 25 percent increase in flow, while a 25 percent increase in rainfall led to a 75 percent increase in flow for that system. These results must be considered hypothetical and cannot be extrapolated upon in terms of impacts to all arroyos or floodplains. However, the analysis demonstrated that precipitation events of increased intensity did place additional structures at risk along the Calabacillas Arroyo system.

Map 7-5: FEMA 100-year Floodplains in the Region



Forest Fire Risk Areas

According to the University of Wisconsin's SILVIS Lab, wildland-urban interface (WUI) refers to the "area where structures and other human development meet or intermingle with undeveloped wildland." Not only does new development pose a threat to the natural environment, but the climate literature indicates the natural environment (i.e., WUI areas) may be at greater risk due to wildfires and pose an increased threat to homes and structures. It is because of the inherent and growing conflicts in these areas that the "WUI highlights the need for ecological principles in land-use planning as well as sprawl-limiting policies to adequately address both wildfire threats and conservation problems."[34]

Wildland Intermix and Interface Area Definitions

Intermix communities are places where housing and vegetation intermingle. In intermix areas, wildland vegetation is continuous, more than 50 percent of the land is vegetation, and density is greater than 1 house per 16 ha.

Interface communities are areas with housing in the vicinity of contiguous vegetation. These areas have more than 1 house per 40 acres, have less than 50 percent vegetation, and are within 1.5 mi of an area that is highly vegetated.

https://www.nrs.fs.fed.us/data/wui/

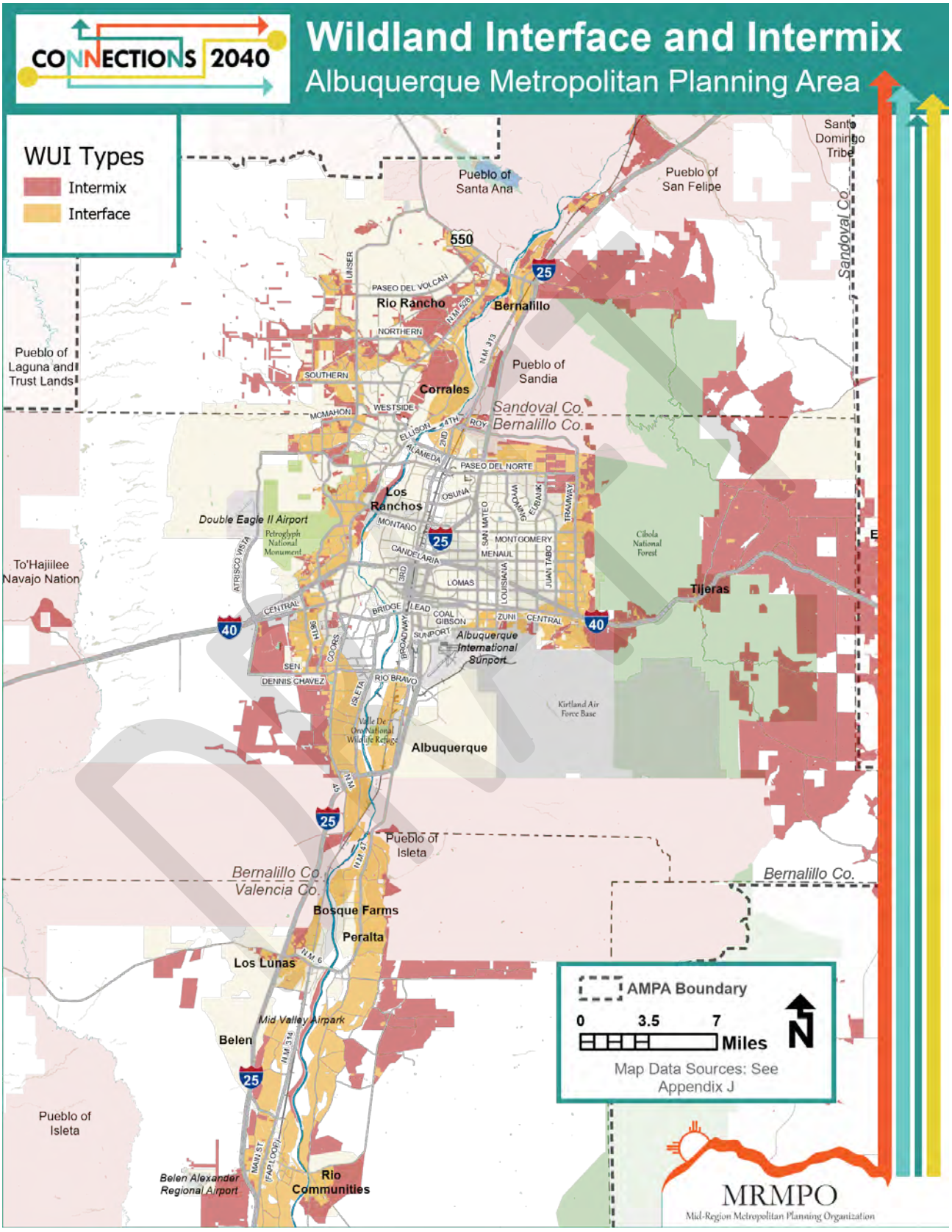
Source: SILVIS Lab

Figure 7-14: Change in Employment plus Households in Vulnerable Locations

[In process of being updated]

[34] V.C Radeloff, et al. "The Wildland-Urban Interface in the United States," *Ecological Applications*, 2005, p. 799

Map 7-6: WUI Areas in the Region



Reducing Wildfire Risk

If you live in a WUI zone or area with increased risk of wildfire exposure, there are several precautions you can take to protect your home and yard against a wildfire. Create a zone of "defensible space" around your house that will slow the wildfire down and possibly direct it around your home. To do this, you must view your yard as a fuel source. Fire will only burn if fuel is present. Fuel can be your landscaping, woodpiles, decks, etc. To create your defensible space, there are some steps you can take within 30 feet of your home, 50 feet if you live in a heavily treed area or 100 feet if your home is on a hillside.

- Introduce more native vegetation.
- Space trees at least 10 feet apart.
- Keep trees and shrubs pruned.
- Move firewood and storage tanks away from home and clear areas at least 10 feet around them.
- Mow your lawn regularly and dispose promptly of cuttings and debris.
- Trim branches so they do not extend over roof or near the chimney.
- Keep the grounds around your home free of pine needles.
- Store flammable liquids in approved metal safety cans.
- Do not connect wooden fencing directly to your home.
- Clear your roof, gutters, and eaves of debris.

If the wildfire gets to the house, another line of defense is the type of materials used on your home's exterior. Building or retrofitting your home with non-flammable materials is another good idea.

- Box in eaves, fascias, soffits and subfloors with fire resistant materials like treated wood, reducing the vent sizes.
- Cover exterior walls with fire resistant materials like stucco, stone, or brick.
- Apply ¼" non-combustible screening to all vent or eave openings.
- Use double paned or tempered glass for all exterior windows.
- Enclose undersides of decks with fire resistant materials.
- Make sure your address is visible from the street.
- Install noncombustible street signs.
- Install spark arresters in chimneys.

Finally, have a plan. Become familiar with your community's disaster preparedness plans and create a plan for your family. Identify escape routes from your home and neighborhood and designate an emergency meeting place for your family to reunite if you become separated. Put together an emergency kit that includes first aid supplies; a portable NOAA weather radio; basic tools; a flashlight; work gloves; fresh batteries for each piece of equipment; clothing: blankets; baby items; prescription medications; extra car and house keys; extra eyeglasses; credit cards and cash; important documents, including insurance policies.[35]

[35] https://www.farmers.com/catastrophe/wildfire-defense/

7.5 Emergency Situations

In an emergency, it is likely that the typical functioning of the transportation system would be affected and altered in some way. Critical components of the region's transportation infrastructure could be blocked or damaged, altering the performance of the system and possibly taking away important access points. Even if there is no direct damage to transportation infrastructure, an emergency could create atypical transportation patterns that overwhelm the carrying capacity of critical roadways or otherwise compromise the functionality of the transportation system.

It is overwhelmingly the case that measures to improve the general performance of the regional transportation system, such as those stated in the *2040 MTP* goals and objectives, are complementary if not exactly the same as those needed to improve the performance of the region during an emergency situation. Maintaining existing infrastructure, expanding multi-modal transportation options, preparing for climate uncertainties, improving access to key sites, and encouraging a mix of land uses in appropriate locations, are all strategies that improve transportation security while also fitting within the stated *Connections 2040 MTP* goals and objectives.

a. Transportation Security

Transportation security includes preparations and plans to prevent, manage, and respond to potential regional threats that would require an emergency response. Because different types of incidents require different responses, it is impossible to have a specific plan for every type of event. It is for this reason that emergency operations plans in the region take an "all hazards" approach, focusing primarily on establishing a framework for coordinating communications and responsibilities among various departments and agencies involved in mobilizing a response. Plans focusing on these more organizational elements of emergency management allow for more flexibility and adaptability to changing circumstances and unknown threats, be they caused by nature, technical failure, human accident, or human intention. Potential hazards commonly identified in existing plans include:

- Natural events such as drought, wildfire, flooding, earthquakes, or severe winter weather
- Civil disturbance/mass gathering with imminent threats of violence
- Release of hazardous material
- Energy or fuel shortage
- Disease outbreak
- Pipeline accident
- Nuclear incident
- Terrorist attack
- Utility outage

b. Critical Transportation Infrastructure

Broadly considered, "critical infrastructure" is all assets, systems, and networks, physical or virtual, that are so vital that their incapacitation or destruction would have a debilitating effect on security, public health and safety, the economy, or any combination thereof. Some crucial examples are the utility and supply systems that deliver food, water, fuel, electricity, and climate control to our homes and places of work.

Local examples of critical transportation infrastructure are:

- Interstate highways – important trucking supply lines and primary evacuation routes in case of large-scale emergencies
- Transit service - ABQ Ride, Albuquerque Rapid Transit and Rio Metro Regional Transit shuttles will be the primary means of getting citizens without privately-owned vehicles to safety
- Rail lines – important for freight supply and passenger transportation within and outside the region
- Airports – in additions to the Albuquerque International Sunport, the AMPA is home to the Kirtland Air Force Base, Double Eagle II Airport, the Mid-Valley Airpark, and Belen Regional Airport
- Fuel supply lines

In emergency situations, a well-functioning transportation system is especially important for transporting responders and resources, accessing affected areas and critical services such as hospitals and shelters, transporting debris to disposal sites, and providing evacuation routes if necessary.

Fuel Supply

The transportation system will not be able to serve emergency operations if there is insufficient fuel for vehicles. This makes the threat of an energy shortage particularly difficult to address when it comes to transportation, especially if the energy shortage affects fuel supply. Currently the region depends heavily on petroleum, and as of 2019, there were no formal plans in the region to deal with a disruption in fuel supply.

Under "informal" policies, the 2012 Energy Assurance Plan, written for the State of New Mexico Energy, Minerals and Natural Resources Department, states that the City of Albuquerque would be able to operate for two to three weeks in the event of a fuel disruption.[36] This is concerning to stakeholders who fear that a fuel shortage would not only cause a region-wide emergency but would also cripple the abilities of emergency management operations. Diversifying fuel options by supporting alternative fuel supply infrastructure is a recommended way to improve resiliency in this area.

Evacuation Routes

While primarily a State, tribal, and local responsibility, Federal support may be required for large-scale evacuations. Such evacuations may include moving incarcerated persons, patients, and those with special needs in local hospitals, nursing homes, and extended care facilities, as well as zoo animals, household pets and service animals out of impacted areas. Significant transportation and shelter coordination and resources would be required. Incident response efforts may also involve air operations for search and rescue, medical transport, and evacuation flights.

Anticipating the movement or evacuation of large numbers of people from affected parts of the region, state and local emergency operations plans identify Interstate 25, Interstate 40, US Highway 550, US Highway 60, and US Highway 380 as roads to be used for primary evacuation routes. State and local plans expect that the majority of evacuations will take place via personal vehicles and that those without access to private vehicles will be serviced by bus, which would involve local transit agencies gathering residents to safe pick-up sites, from where they would depart to congregated care and shelter facilities in established safe zones. Additional traffic control will be necessary to ensure orderly flow of traffic, coordination of parking at reception and registration centers, and providing direction to assistance facilities.

[36] Burcham and Associates, "State of New Mexico Energy Assurance Plan," Prepared for the State of New Mexico, Energy and Minerals Department, 2012, p 63

Alternative Routes

It would be an exceedingly rare and extreme event that would require a full evacuation of the region, however there are some local stakeholders who are concerned about the lack of alternative routes within and leading out of the region, as well as limited access points to these routes. The ability to address this issue is limited by the region's river and mountain topography, but also the prohibitive costs of constructing and maintaining additional evacuation routes that would be otherwise redundant.

During an emergency event it is most plausible that an evacuation would be required only for specific areas of the region. Improving the ability to respond to these kinds of situations is more easily addressed through the design and layout of internal roadways. **The layout of road networks in certain neighborhoods in the region makes them more vulnerable.** In these typically rural and suburban neighborhoods, too few access roads and a lack of connectivity provide insufficient ingress and egress points should there be a need for large numbers of vehicles to simultaneously enter or exit. This setup could exacerbate transportation challenges during an emergency.

c. Network Resiliency

Upon review of these emergency planning documents, and recent correspondence with local and state security focused departments, groups, and committees, MRMPO finds that the best way to address transportation concerns under an all-hazards approach to security planning is to improve transportation system resiliency and flexibility. Following are general aspects of the region's transportation system that are key to maintaining resiliency and flexibility in the wake of an emergency situation. Efforts to improve regional transportation security should focus on these aspects.

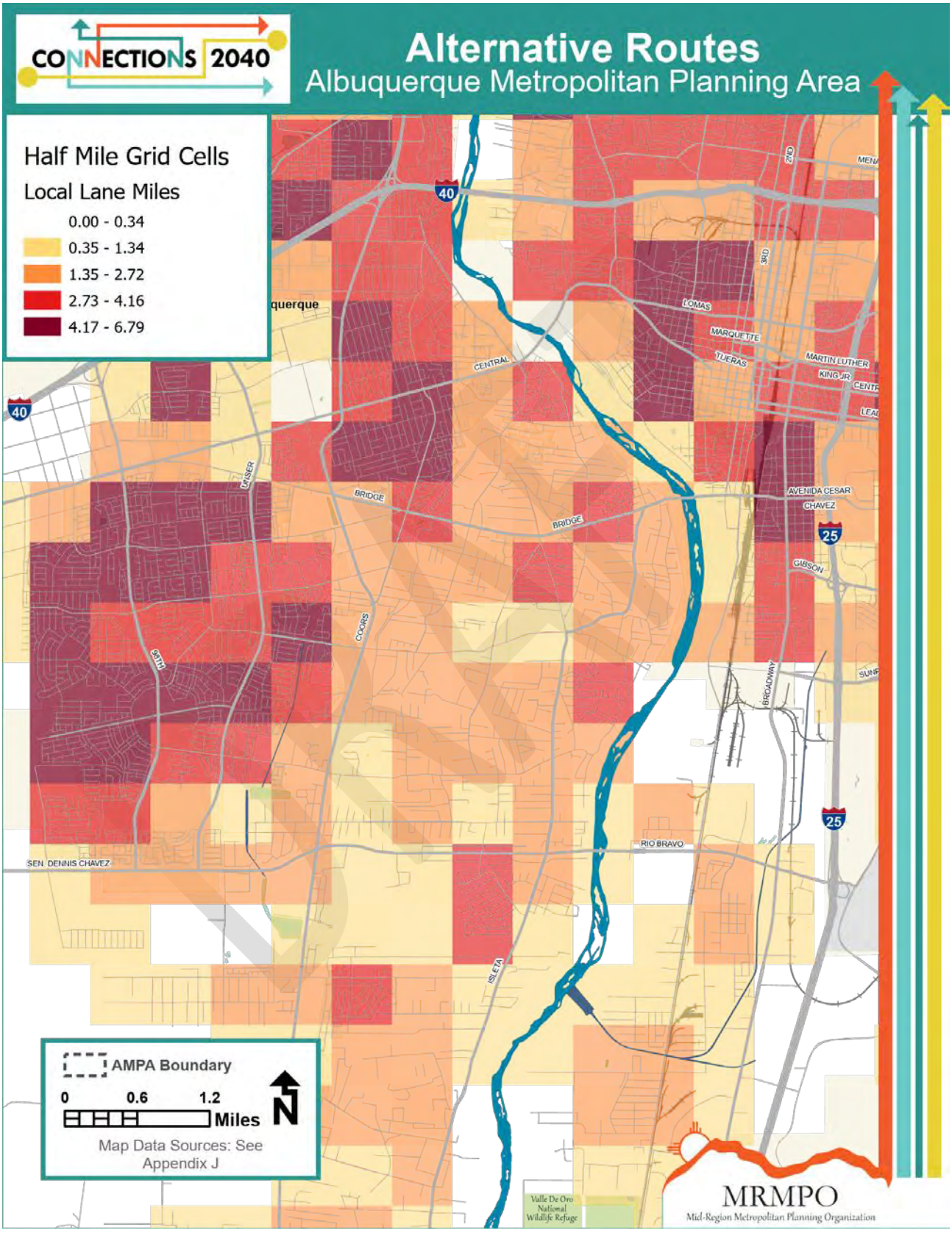
- Increasing connectivity: Increasing the connectivity of roadways, including local streets, would improve the performance of the transportation system in an emergency by permitting better access to and from affected or otherwise important sites, as well as increasing the possibility of using alternative routes for evacuations.
- Promoting alternative fuels: The loss of a gasoline and/or diesel fuel supply within a community could be devastating during an emergency event, debilitating first responders and others. Diversifying fuels is a preparedness strategy that should be implemented prior to, and during, an emergency event. By diversifying the types of fuel used within the community, not all fleets will be impacted by a specific fuel outage. Possible alternative fuel options include natural gas, electric, hybrid, propane, and biodiesel.
- Promoting alternative modes of transportation: Alternative modes provide more options for moving people in and around the region both at the onset of an emergency event as well as during the recovery phase. In New York City after the terrorist attack of 9/11, the redundancy of the transportation system — that is, the options available from roadway, transit, and pedestrian pathways — enabled residents to continue to move throughout the city.[37] Additionally, transit can be run on alternative fuels and generally requires less fuel on a per person basis. Therefore, increasing transit capabilities in the region would provide flexibility in the event of a fuel shortage.
- Promoting a mix of land uses and complete neighborhoods: An emergency event may create challenges with distributing key resources and services to residents as well as communicating information. Areas that have well-defined and accessible civic and public places, such as schools, neighborhood centers, and commercial districts, make it easier to coordinate these aspects of emergency operations. These places put immediate resources nearer to residences and provide nodes for distribution of resources, information, or medical countermeasure procedures.

[37] Dornan, D. L., Maier P.M. "Incorporating security into the transportation planning process." *NCHRP report 525: Volume 3*, 2005

- Maintaining a state of good repair: Keeping roadways in a state of good repair is needed to ensure that infrastructure can handle extreme events and evacuation needs during and emergency situation.
- Increasing Intelligent Transportation Systems (ITS) and traveler information services: ITS can be used to collect and analyze real-time roadway conditions during an emergency. Traveler information services inform the traveling public about roadway conditions and alternative routes that may be utilized, thereby reducing congestion and increasing response time of emergency vehicles.

The map below provides a close up the connectivity of local streets overlapped with the major roadways. This example illustrates how in certain areas there is redundancy should there be an emergency situation, and in other areas there a fewer through options or only circuitous routes exist allowing access to major roadways or locations like the airport. Spacing of the major roads is another important factor to consider.

Map 7-8: Alternative Routes along the Local Network



d. Emergency Management Responsibilities

Several stakeholders at the state and federal levels are involved in transportation security issues. Emergency Operations Plans in the region have a tiered approach to responding to emergency situations depending on the magnitude of the event. If the first responders are overwhelmed, they may call for the activation of a local Emergency Operations Center which coordinates additional resources and may even request assistance from neighboring jurisdictions. In the case that local emergency operations are overwhelmed, the State of New Mexico Emergency Operations Center can be activated. In extreme cases, help from the federal government may be called for.

State All Hazard Emergency Operations Plan

The New Mexico Department of Homeland Security and Emergency Management (DHSEM) has primary responsibility for maintaining the NM All Hazard Emergency Operations Plan, enacting the Emergency Operations System, coordinating the state response, and staffing the NM Emergency Operations Center. The Emergency Operations System provides the structure for organizing, coordinating, and mobilizing resources. The Emergency Operations Center (EOC) is located on 13 Bataan Blvd., Santa Fe on the campus of the New Mexico National Guard. In the event the primary state EOC becomes inoperable there is one fixed alternate EOC as well as one contingency EOC. The fixed alternate EOC is the DHSEM Mobilization Center at 5880 Office Blvd NE, Albuquerque, NM. The contingency EOC consists of a mobile DHSEM command vehicle with an equipment cache to establish an EOC capability at any suitable location.[38]

The New Mexico All-Hazard Emergency Operations Plan applies to state departments, agencies, special districts, commissions, boards, all divisions of tribal, pueblo, nations, and local government, and volunteer private organizations with emergency responsibilities. The plan designates preparation, response, and recovery activities by each agency according to the Emergency Support Function (ESF) format.

The MRMPO coordinates as appropriate with state departments designated support agencies of the Transportation Emergency Support Function (ESF). The purpose of the ESF is to establish procedures for using state transportation resources for an emergency affecting transportation systems and infrastructure. The NMDOT is the coordinating agency for the designated support agencies before, during, and after an incident.

Activities within the scope of this ESF include:

- Collecting, evaluating, and sharing information on transportation infrastructure damage and analyzing the impact of the incident on transportation operations locally and regionally
- Coordinating the movement of people and resources to, from, and within the incident area
- Coordinating requests for federal and civil transportation support including air traffic control
- Participating in decisions regarding issues such as critical facilities closures, quarantines, and evacuations
- Identifying temporary alternative transportation solutions that can be implemented by other agencies when systems or infrastructure are damaged, unavailable, or overwhelmed;
- Coordinating the restoration, recovery, and safety/security of the transportation infrastructure

Local Emergency Operations Plans

Bernalillo County and the City of Albuquerque manage an Emergency Operations Center, where the municipalities upper management with designated response roles assemble to determine the best course of action during significant emergency events.

[38] New Mexico Dept. of Homeland Security and Emergency Mgmt. *State of New Mexico All-Hazard Emergency Operations Plan*. Revised, December 2016.

To better prepare for and minimize vulnerability to such hazards, the New Mexico Office of Emergency Management (NMOEM) and the Federal Emergency Management Agency (FEMA) provided support to undertake a hazard mitigation planning process. The resulting Hazard Mitigation Plan for Bernalillo County / City of Albuquerque identifies and profiles hazards that can affect the metro area, assesses vulnerability to these hazards, and identifies mitigation actions. The Plan also includes an implementation strategy for preferred mitigation actions, as selected and prioritized by a multi-jurisdictional community-based planning team. While the MRMPO is not named specifically in these plans, the data and tools available through MRMPO could be valuable resources in emergency preparedness planning. Additional transportation security planning efforts for the region could involve the following:

- Conduct vulnerability analyses on critical regional transportation facilities and services
- Analyze the transportation network for redundancies in moving large number of people and for strategies dealing with "choke" points and bottlenecks
- Analyze the transportation network for emergency route planning/strategic gaps in the network
- Provide forum for security/safety agencies to coordinate prevention strategies
- Conduct transportation network analyses to determine most effective recovery investment strategies
- Act as forum for regional assessment of organizational and transportation systems response
- Conduct targeted studies on identified deficiencies, priority reconstruction needs and recommend corrective action to restore critical and strategically important transportation facilities

Regional Transportation Management Center (RTMC)

A Regional Transportation Management Center (RTMC) housing multiple-agency transportation operations in a single co-located facility is in the final stages of development in the AMPA. The Regional TMC will consolidate monitoring of traffic conditions, improve communications, reduce traveler delays, and improve safety for all users of the transportation system. It will also play a critical emergency management role across jurisdictional boundaries by assisting in the coordination of emergency response for traffic incidents or other emergencies and reporting of hazardous travel conditions to drivers via dynamic message signs.

Hazardous Materials

Hazardous materials can include toxic chemicals, radioactive materials, infectious substances, and hazardous wastes. An accidental hazardous material release can occur wherever hazardous materials are manufactured, stored, transported, or used. Such releases can affect the nearby population and contaminate critical or sensitive environmental areas. Typically, hazardous material releases also cause severe damage to transportation routes and facilities. The transportation system has a unique connection to the threat posed by the possible release of hazardous material, in that hazardous materials are transported through the region daily.

The City of Albuquerque and Bernalillo County constitute the State's most populous area and, consequently, have the most residents at risk of exposure to hazardous material releases. The "Big-I" intersection in the middle of Albuquerque and railway freight traffic present the highest potential routes for some type of hazardous material release. A preliminary study of the hazardous materials traffic through Bernalillo County identified 22,000 railcars containing hazardous materials flowing through Albuquerque in a single year.[39] A possible mitigation action for mobile hazardous materials may be to restrict hazardous materials transportation through the most populated portion of the County during peak traffic times.

[39] *Hazard Mitigation Plan for Bernalillo County / City of Albuquerque, New Mexico, Final Report* – May 2007

NMDOT Monitoring and Inspections

The New Mexico Department of Transportation monitors and inspects commercial transports in an effort to ensure that hazardous material movement is conducted in compliance with mandated regulations. [40] In the event of a release, agencies from local fire departments up to the federal level may need to be involved. With support from the Regional Transportation Management Center, NMDOT personnel would assist in coordinating the containment response; safety and security related actions concerning movement restrictions, closures, quarantines, and evacuations.[41]

[40] *Bernalillo County/City of Albuquerque/ Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA)/Village of Los Ranchos de Albuquerque/Village of Tijeras Hazard Mitigation Plan*, July 14, 2015. P.170

[41] *City of Albuquerque Comprehensive Emergency Management Plan; Annex III: Response Functions; Emergency Support Function #1 – Transportation.* August 2019.